INTERNATIONAL COMPARISON OF RESIDENTIAL ENERGY USE:

INDICATORS OF RESIDENTIAL ENERGY USE AND EFFICIENCY
Part One: The Data Base

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This summary report presents information on the end-uses of energy in the residential sector of seven major OECD countries over the period 1960-1978. Much of the information contained herein has never been published before. We present data on energy consumption by energy type and end-use for three to five different years for each country. Each year table is complemented by a set of indicators, which are assembled for the entire 20-year period at the end of each country listing. Finally, a set of key indicators from each country is displayed together in a table, allowing comparison for three periods: early (1960-63), pre-embargo (1970-73), and recent (1975-78). Analysis of these results, smoothing and interpolation of the data, addition of further data, and analytical comparison of in-country and cross-country trends will follow in the next phase of our work.

1 BACKGROUND

In the Spring of 1979 the US Energy Information Administration asked the Lawrence Berkeley Laboratory (LBL) to gather data on residential energy use in Canada, Japan, Sweden, Germany, France, Italy, and the United Kingdom (UK). The existing literature at the time contained little data that accurately represented present or past consumption of energy by end-use and fuel in the residential sector. In the first phase of this project (Tasks 1 and 2)[1], demographic, economic, and housing data were assembled after several trips to each country turned up original data in a variety of places.

At present LBL is assembling as much data on actual energy consumption by energy type and end-use as exists for the countries in the study. Although data from other countries contains some omissions, it is believed that LBL has turned up most of the important sources of information. Additional data -- including other years not presented in this report, energy prices, and appliance ownership -- are contained in our complete data base.

It should be emphasized that the present report represents the culmination of the data-gathering and "purifying" phase of our work. Much analytical work remains ahead as we seek to understand the information we have assembled. This includes the use of statistical techniques to understand in an international context the development of residential energy consumption during the past two decades; and the application of our results to both forecasting and policy analysis within the OECD and specifically to the case of the United States.

2 STRUCTURE AND INTENSITY: INDICATORS OF ENERGY USE

Residential energy consumption is a function of the structure and intensity of energy use (see Schipper, 1979).[2] Structural factors both define tasks for which energy is used and shape the way in which it is used. They include dwelling size, family size, climate, appliance ownership, and so forth, and often include measures of lifestyle (ownership of a freezer) or behavior (indoor temperature). Energy intensities tell us how much energy is used for a given task, and are in part determined by the structural factors existing in a particular place. Energy per dwelling, energy per ton of industrial output, and energy per passenger-mile are all intensities. Both structure and intensity are affected by economic factors -- especially household incomes and energy prices. Here, we present data on disposable income, but not prices, which we reserve for a future report.

Our work has a three-fold focus:

- To describe changes in energy intensities over time and differences among countries for the major residential energy end-uses.
- To describe changes in structural factors and relate them to the observed energy intensities.
- To develop indicators of energy use that may be used to assess progress in energy conservation.

Of course, any piece of data can be an indicator of something, but most published energy data are not really useful as true indicators of conservation. Energy intensities have been used by various analysts in both time-series comparisons of energy use within a country and comparisons among countries. Often, however, simple intensities provide insufficient information and can be misleading (although it may be the best one can do).

To assess conservation, we believe it is important to connect energy intensities with the key structural factors that affect energy use. Thus, where reasonable and possible, we have combined energy intensities and structural factors to form energy conservation indicators. A simple example is the indicator "Heat/dw/DD" -- average energy used for space heating per dwelling per degree-day. Comparing the intensity "Heat/dw" between years within a country or among countries ignores the effect of climate. We can account for climate by dividing this intensity by an average number of degree-days, an approximate measure of the need for heating.

Indicators are both useful summaries of many kinds of data as well as indexes of the performance of energy-users or energy-using equipment. Thus, indicators measure the relationship among structure, intensity, and total energy use in a given end-use. Chosen carefully, they can provide much more useful information regarding the effect of energy conservation than simple intensities.

Since we have uncovered an enormous amount of data and analyses, it is important to sort out the various quantities that relate to the major end-uses for energy in homes. An informative but concise way to display residential energy use data is shown in Table 1. At the top of each table, we present basic structural information relevant to the consumption of energy in that year. Data on total end-use energy consumption, energy-consuming stock, and unit (specific) consumption follow in the body of the table. Below the table, we give selected indicators of both structure (saturation of heating equipment by energy type) and energy use.

We find this scheme useful for summarizing the number of units (such as households or stoves) using a given fuel, consumption/unit, and total consumption. By keeping fuels separate as much as possible, we avoid the notorious accounting problems inherent in aggregating fossil fuels, electricity, and even district heating.

Once information has been recorded in this fashion, it is possible to construct indicators of space heating, hot water, cooking, and electric appliance energy use. (The latter is defined as residential electricity use excluding space heating, hot water, and cooking. This is often called "electric specific appliance" consumption).[3] In order to provide a compact overview of a particular end-use, it is often necessary to aggregate electricity and district heating with fossil fuels into a single indicator (such as "Heat/dw/DD"). If one were to simply use end-use energy in constructing the indicator, a problem would arise, since electricity and district heat do not have conversion losses within the building boundary. Thus, it is necessary to express these energy sources in terms of fossil fuel-equivalent energy. Otherwise, electrically-heated dwellings would appear to be more energy-conserving than fuel-heated dwellings of the exact same construction. Thus, we ask: if dwellings had been heated by fossil fuel instead of electricity, how much energy would have been used? (Note that this is not the same as "resource" or "primary" energy). For our purposes, a rough approximation is sufficient. As a standard convention when aggregating diverse energy sources, we divide electric and district heat intensities by a hypothetical fuel conversion efficiency of 65%. By making this

Table 1

RESIDENTIAL ENERGY USE-

Year: Population: Dwellings:

SFD %: Disposable income per capita: Climate Index:

Energy type	Heat	Hot Water	Cooking	Appliances	Total
Oil,PJ					
-Stock,10^3					
-Unit Cons,GJ					
Gas,PJ					
-Stock,10^3					
-Unit Cons,GJ					
Solids,PJ					
-Stock,10^3					
-Unit Cons,GJ					
Electricity,PJ					
-Stock,10^3					
-Unit Cons,GJ					
-Dist. Heat,PJ					
-Stock,10^3					
-Unit Cons,GJ					
TOTAL,PJ					

STRUCTURAL INDICATORS	ENERGY USE INDICATORS
% dw oil heat	GJ/dw, end-use
% dw gas heat	GJ/dw, primary
% dw elec heat	% oil, end-use
% dw central heat	% elec, end-use
	Heat/dw/DD
	Appliance elec/DI

adjustment, we avoid the bias that structural shifts in heating energy type can cause. This is done for heat and hot water, but not for cooking, where the problem mentioned above is less clearly present. We emphasize that these conversion factors are not fixed, and note that our disaggregated presentation allows the user of this data to ignore the aggregation or aggregate in some other way.

2.1 Use of Indicators

In Table 2 we give a list of indicators that we develop in the data section of this report. Key indicators are shown in summary tables at the end of each country report and in the seven-country summary of all our work. It should be remembered that indicators are usually averages over a diverse set of dwellings. Once these indicators are evaluated, the changes in energy use over the past decades can be analyzed. For example, increases in space heating per dwelling can be related to changes in the mix of single- and multiple-family dwellings (henceforth SFD and MFD respectively), increases in area, increases in the penetration of central heating, and inferred increases in indoor temperature.

These indicators can serve as important modeling tools. This is because they allow explanation of energy use in terms of amenity level, such as amount of centrally-heated floor space, and intensity, or energy/amenity. The dramatic increases in residential energy use in the 1960s appear to be connected to the rise in central heating and appliance ownership. However, hot water use in many countries does not appear saturated yet. By breaking apart energy consumption by end-use and fuel we can account carefully for both changes in amenity level and changes in efficiency that rising incomes and energy prices may bring about. When energy uses are aggregated, a host of accounting problems make careful analysis of trends almost impossible.

Consider how this information might be important for forecasting. A simple analysis of trends would show that between 1972 and 1975 increases in energy use occurred in many countries, even as energy prices rose in nominal and, to a lesser extent, real terms. A model based upon these observations might lead us to believe that the long-run income elasticity of residential energy use was considerably greater than one, while the price elasticity was very small, since growth continued during the immediate post-embargo period. However, a more careful analysis, (which we expect to perform on the data we have gathered), would take note of the enormous increase in saturation of central heating, modern hot water devices, and kitchen appliances. It appears that this structural growth explains the increases in energy use. Of course, such growth is fueled by increasing income levels. But the rate of increase in the demand for these amenities is slowing due to the approach of saturation limits. Additionally, the energy intensities of centrally-heated dwellings in various countries appear to be falling as prices begin to rise in real terms. A model rich in these details allows us to more carefully predict the effects of saturation and prices on the actual uses of energy.

Table 2
INDICATORS OF RESIDENTIAL ENERGY USE

Indicator	Comments
	HEAT
Heat/dw	Does not consider effect of climate or dwelling size
Heat/dw/DD	Allows approximate correction for climate
Heat/dw/DD/area	Reflects changes in living area
	HOT WATER
Hot Water/dw	Does not consider changes in persons/dw
Hot Water/cap	Better indicates changes in hot water use patterns
	COOKING
Energy/dw	Cooking energy is less dependent on persons/dw
	APPLIANCES
Elec/dw	Indicates presence and use of electric-specific energy service; does not consider changes in persons/dw
Elec/cap	Somewhat closer measure of changes in electric-specific consumption
Elec/DI	Ratio of total sector electric-specific consumption to total personal disposable income, an indicator of ability to own appliances
	MISCELLANEOUS
Energy/dw, end-use	A gross indicator of sector energy consumption
Energy/dw, primary	Allows consideration of electricity and district heating conversion losses
% oil, end-use	Indicates oil dependency of the sector
	STRUCTURE
% SFD	Housing stock in detached or semi-detached single-family dwellings.
% central heat	Indicates changes in heating structure; correlated with heating energy use
% dw oil heat	Fraction of dwellings heated by oil; gives sensitivity of sector to oil problems

Analysis of this data will also shed light on many questions often posed about energy conservation in an international context:

- What is the role of prices and incomes in shaping residential energy use?
- What are the energy consequences of apartment vs single-family dwelling living?
- How have lifestyles explicitly affected residential energy use?
- How well have conservation programs fared in different countries?

3 COMMENTS ABOUT THE DATA

3.1 The Data Problem

Data on residential energy use come from a variety of sources and institutions. Historically, few countries have kept data on residential energy use by end-use. Data in Germany, France, Italy, and Sweden that appeared in energy balances were aggregated with commercial and public sector energy uses. Energy balances in Canada and the UK considered the residential sector separately, but there is confusion concerning apartment buildings and commercial buildings, particularly where master-metering was common. As is well known, data kept by the major international organizations (United Nations, OECD/International Energy Agency, Common Market) were not disaggregated until recently.

We therefore turned to energy companies, government studies that were not usually considered "official" and therefore not reflected in "official" energy balances or submissions to the major international organizations, results of statistical surveys, and private surveys and studies. Among these sources, there is sometimes disagreement as to energy use, particularly in the 1960s. We have attempted to reconcile different data sources.

We have chosen to document our information both by giving the source of data and by giving information on how data were derived or obtained. In some cases (Canada and Germany), we made use of compilations assembled by companies or researchers in the respective countries, supplementing and corraborating these with the many other sources we have collected. On the other hand, we publish our own such analysis of consumption developments in Sweden because none exists, and because our goal forced us to survey energy suppliers and examine hundreds of other related documents that appear to have been skipped over in most discussions of energy use in Sweden. In many cases we make significant additions to the existing literature by disaggregating some important uses, and, in the Swedish case, by making what we feel are important corrections to the existing literature (see Schipper, 1981).[4]

We publish in this document basic data on structural factors and energy use in the residential sector for several years in the 1960-78 period, as well as summary indicators of residential energy use. Our complete data base contains a great deal of information not presented here, including full and partial breakdowns by end-use and fuel for other years. In some cases, we have separate energy-use data for

single-family and multi-family dwellings. Additional information continues to flow in from our network of contacts.

3.2 Construction of the Data Base

Each country presented different problems in developing an accurate time-series of residential energy consumption. In some cases, work proceeded from the top down. That is, total consumption of a particular fuel for an end-use was well or reasonably well-known. Combining this with the stock of dwellings or devices using that fuel allows one to calculate the measure of intensity, energy for a certain task per dwelling (which we call "unit consumption"). Some manipulations are often necessary until a self-consistent account of every unit of energy of a given kind is obtained.

Sometimes the contrary approach is taken, when totals are not well known but specific consumption and equipment saturation is reasonably well-determined. This is possible when careful surveys have been carried out. For example, oil company data in Japan, Canada, Sweden, and Germany give a fairly accurate accounting of energy use for space heating on a per customer basis. Knowing the number of oil heating customers in various climate zones, these numbers can be used to reconstruct the entire consumption for the whole country. The German Mineraloel Wirtschaft Verband (MWV) compared estimates of residential heating oil use from six major oil firms doing business in Germany. These estimates differed by only 10% from highest to lowest.

3.3 Estimation Procedures

Given data on stocks of equipment and dwellings, engineering estimates of unit consumption, historical data on deliveries of all fuels, surveys of actual energy consumption by dwelling type and with knowledge of the equipment in the home, we were able to assign energy consumption values to various kinds of functions. Knowing summer consumption in all-gas or all-electric homes allows us to separate climate-dependent heating from other components of energy use. Given homes with a split of gas and electricity (or other mixes), we could determine consumption for a given device by comparing energy use in homes with similar equipment except for the device in question. Studies in Germany have attacked the problem in this manner, and we have encountered similar work in the UK and Canada. In Japan the primary source of data is consumer expenditure estimates, which are relatively reliable because unit

energy costs have historically been fixed. In Italy and Sweden, little detailed estimation of unit consumption has taken place, while estimates of annual specific energy use in France cover only the period since 1973.

Where several fuels and end-uses are involved, examination of differences in winter/summer consumption, or comparison of homes with and without a particular end-use allows estimation of a given quantity. In Sweden, for example, the majority of gas users have only stoves; in Canada, homes with gas heating usually have gas hot water but either electric or gas cooking. Comparison of summer consumption of homes with either kind of cooking allows estimation of both cooking and hot water, which can then be subtracted from winter gas consumption to estimate heating.

Cooking energy use can be relatively well-determined by statistical means. Homes with only one kind of cooker (gas or electric) can be compared. In some countries, for example, many homes use gas only for cooking, and data on their consumption shows how much energy is required for cooking. However, few good historical data exist for cooking energy consumption. Thus, some estimation is often required in constructing a time-series for cooking.

Data on appliance energy use are varied. For recent years there exist reasonably good engineering estimates of annual energy use for "average use", but such information is rare for the 1960s. In this report, however, we treat appliance electricity use as a residual. Future work will look more closely at differences over time and among countries in appliance energy use.

3.4 Accuracy and Errors

What about errors? It is difficult to quantify the uncertainties inherent in the data we compiled from each country, but we have tried to describe the assumptions and derivations we have made ourselves. However, we can describe certain systematic errors that may creep into the data.

- Confusion over degree-day assumptions -- base, regional, and yearly variations. The former might mean an error of 5% in degree days for each degree our base differs from others; the latter two factors, less than 3%.

- Misdefinition of housing stock types, such that the fraction of

the stock found in SFD may be incorrect.

- Incorrect definition of house area.

- Incorrect number of occupied dwellings or size of persons/dwelling. Confusion of second homes or vacant homes with primary homes in the dwelling stock could constitute a 15% error in the case of Sweden or France, if second homes were not well-identified; in other countries, mistakes are more possible. Confusion over the number of occupied dwellings -- and whether or not they are heated -- also exists in some countries. Because of these factors, the number of dwellings given could be wrong by ~2%.

- Confusion of energy consumed in large apartment buildings with that in commercial buildings (possibly a 10% error in MFD consumption, based on experience with data in the US, Sweden, and Canada).

- Mistaken idenfication of heating fuel in a survey (typically 2-3% of respondents in Sweden do not know how their dwelling is heated because they do not pay directly for central heat!).

Despite these errors, it is reassuring to note that the derived consumption sub-totals for the various end-uses balance fairly well with known total sector energy consumption. We caution the reader, however, that space heating consumption, the most significant end-use, is particularly subject to the above uncertainties; more often than not the level of consumption for hot water and cooking is constructed from unit consumption estimates based on the literature. Since we have been able to check actual use of heating fuels against stock-wide calculations for Germany, Sweden, Canada, and France, we are reasonably confident that our figures on the whole are accurate to within 10%.

the accuracy of the data varies among countries. Although there are exceptions for some fuels (especially solids), we can say that estimates of consumption for the 1960-72 period are most reliable for Germany and Canada; estimates for the UK in the case of electricity and France in the case of gas and electricity are also reasonably reliable. Uncertainties over equipment ownership make unit consumption data from Japan before 1973 uncertain, but comparison of total electricity consumption derived from expenditures and that shown by utility companies is close (to within 5%), suggesting that the totals presented herein are accurate. The case of Sweden and Italy is difficult to judge, since our own estimation procedures have yet to be validated by our contacts in those

countries. Data on housing stock and heating equipment in Sweden are better than in most countries, because of the predominance of central heat, although the German and Canadian data are also reasonably complete and reliable.

Hot water consumption is probably the most uncertain, given the diversity of fuels, dwelling types, family sizes, and hot water heating systems (direct heaters, independant storage heaters, storage heaters that have to be fired with coal or wood, storage heaters dependant upon the central heating system). We have found few good measurements of hot water consumption and associated energy use. Thus, small variations in hot water use over time within a country should be viewed with suspicion, although we believe the great differences that still exist among countries are significant. Note that even a 20% error in subtraction of hot water from heating leaves the quantity of fuel consumed for heating relatively unchanged, since hot water usually requires only ~20% of the energy consumed for space heating.

We caution readers who want to check our results with those from other surveys to make sure that comparable work uses the same conventions (end-use energy, climate adjustments, etc.).

4 TERMS & DEFINITIONS

In order to allow some comparability among countries, we have adopted several conventions which we have applied for all. A discussion of the most important of these follows.

4.1 Central heating

The definition of central heating varies among countries. In Germany and the UK, for example, electric storage heat, which represents the bulk of all electrical heating in those countries, consists of room heaters and is not considered central. In Sweden and Canada, however, storage and direct-acting heat is often water-borne and found in every room ("baseboard" heaters), and is considered central. Central heating in Italy means heating from one central system in apartment buildings, while elsewhere it is taken to mean the presence of heating in every room (for consistency, the Italian central heating fraction considered here includes the so-called "impianti autonomi" -- autonomous systems --, which are centralized with regard to the dwelling). In England, every room may have a heater but each heater is autonomous and fuels may differ.

For our purposes, central heat means heat produced in most or all rooms of a house by a single heating device, or heat produced in most or all rooms by modern electric or gas heaters. Small wood, oil, gas or coal stoves are not counted as central heat. "Etageheizung" (floor heating), common in German apartment buildings, is included with central heat, as is heat provided by district heating stations. Electric heating in Sweden, France, and Canada is primarily central; that in Germany, England, Italy, and Japan is not. (Where information permits we indicate the magnitude of the use of small portable electric heaters). We caution that comparison of this important structural indicator among countries will be imperfect.

4.2 Climate

Space heating energy demand, which accounts for 60%-80% of end-use energy in the sample of countries, is in large part a function of climate. If one is to compare energy use either over time or among countries, it is necessary to account for the effects of climate. Unfortunately, these effects are accounted for in different ways among the countries in our sample. All use the degree-day system, by which the

difference between the actual outdoor temperature and some reference temperature is integrated over the heating season to give a measure of heating needs.* However, the reference temperature and the definition of the heating season differ among countries. In Sweden, the counting of heating-season days depends on whether the average daily temperature in spring and autumn falls below a value (12 or 13° C), and the base temperature is 17° C to account for the free heat mentioned above. In Germany, the base temperature is higher, but heating days are defined according to a 15° C base. In England, the official values for degree-days are based on a far lower reference temperature (as in Japan) than is the case in Germany, Sweden, or North America.

The present work has not permitted a deeper analysis of the differences in counting degree-days. We are aware of ongoing work by Prof. Arne Elmroth, Royal Inst. of Technology, Stockholm, that will be made available to us at a later date. For the time being we present in Table 3 the average number of "official" degree days in each country, the base temperature, and an estimate of the average number of degree days in a normal year if the base temperature 18C is adopted. Knowing the approximate length of the heating season, we can adjust the "official" totals to indicate what the approximate degree-day value would be if the same base were used in all countries.

To be accurate, year-to-year variations should really be evaluated on a daily basis for each base temperature. Lacking the necessary weather data, we transform yearly averages in a simple linear manner from one base to another. Note that a simple yearly average temperature is a very inaccurate measure of heating needs, since it includes many weeks of temperatures above the heating threshold, averaged against temperatures when heating actually takes place. In other words, the average temperatures used in degree-day calculations should be measured over periods close to the average response-time of a house -- the time it takes a house to warm up with increases in outdoor temperature. Some studies (Munther, 1974)[5] use hourly temperature averages and arrive at

*Note that because the degree-day calculation depends on assuming a certain indoor temperature, it is a function of behavior or lifestyle, and therefore not strictly a physical quantity. However, it is possible to construct a physical index of climate by referring all temperatures to some agreed on reference that is independent of observation. In more careful studies, the reference temperature is taken to be that outdoor temperature at which the heating system typically goes on. This temperature depends on the amount of heat gained by the house from appliances, cooking, hot water, people themselves, and the sun, as well as temperature losses due to wind.

Table 3
CLIMATE FACTORS AND RESIDENTIAL ENERGY USE

Country	Base	Degree-Days (nominal)	Range of stations	Adjusted to 18° C	Season (days)
		Degree-Days			
CANADA	18°C	4581	4000-8000	4581	225
FRANCE	18°C	2200	1300-3500	2200	220
GERMANY	20°C[a]	3613	3200-4000	3163	225
ITALY	18°C	2140	700-3000	2140	150
JAPAN	14°C	1000	600-3000	1800	150
SWEDEN	17°C	3760	3080-6200	4010	250
UK	15.5°C	2380		2917	180

Sources: Canada -- Shell; France -- IEJE, GdF; Germany -- Esso, based on Deutsche Wetterdienst; Italy -- IFA, CNR; Japan -- IEE; Sweden -- OeFF, VVS; UK -- Building Services Research. (See country sections for abbreviations).
a - the base for counting heating days in Germany is 15° C.

significantly higher degree-day totals than those using monthly averages.

4.3 Saturation

Saturation refers to the number of dwellings possessing (or having access to) a particular energy-consuming device. A dwelling may have more than one of a given device. (Homes with two refrigerators in Sweden are not uncommon). In the case of hot water and cooking devices, houses in England and Germany may own more than one device that use different fuels. In such cases, we give the number of devices rather than dwellings. However, we are not always able to tell directly how much energy a household uses for a given purpose, since this multiple-ownership obscures use/dwelling. Multiplying use/device by the number

of devices per dwelling gives use/dwelling (assuming for example, that dwellings with only a coal stove use as much coal for cooking as those with both coal and electric stoves).

4.4 Appliances

We try to estimate total electric-specific appliance energy use: electricity used for motors, lighting, small appliances, electronics, or small cooking devices, excluding large stoves, hot water heaters, and portable or central heating systems. One reason for measuring this consumption separately is that it is least affected by the availability of gas for cooking or other fuels for heating. This electricity use should correlate well with disposable income, the parameter that best describes the family's ability to purchase appliances. While low electricity prices may explain the split between electricity and its competitors in the heat-related uses, there is little use of competing fuels in the electric-specific category (particularly since most washing machines in Europe make their own hot water from electrical elements inside the device).

Our data base includes extensive appliance saturation data not presented here. Additionally, we have found estimates of unit consumption for major appliances for neary every country (in some cases, for several years). However, few of these estimates are based upon laboratory tests or field measurements. It is sometimes possible to describe differences in electric appliances that may explain different estimates in unit consumption, and very recent information from manufacturers describe for the first time test measurements of energy consumption. In a future report we will deal more thoroughly with appliances and electricity use.

4.5 Housing Stock

Most of the housing stock data for this study was assembled in an earlier phase (Tasks 1 and 2),[1] although we have corrected and added to our earlier data with further information. The term "SFD" refers to detached one- and two-family houses, row houses, terraced houses, and farm dwellings. Exceptions are found in Canadian and Italian data, where row and terraced houses are counted with MFD (multiple-family dwellings). In every country, dwellings counted for energy use purposes exclude residences in institutions, commercial establishments, and other non-residential buildings. (These usually account for 2% of the

population and 2-3% of all residences).

Since incomes, dwelling size, and family size will in general be different in apartments and in detached homes (although Sweden may be an exception with regard to incomes and area/capita), it is important to look, where possible, at energy use in these dwelling types separately. For heating, this has been possible in some countries. Since the kind of fuel or appliance may be distributed unevenly among these dwelling types over time, and since the relative distributions of SFD and MFD themselves may change markedly (Sweden and Canada), the overall use of energy per dwelling for a given purpose may change. For example, nearly all gas stoves in Sweden have been found in apartments, while electric stoves in the early 1960s were more evenly distributed between SFD and MFD. Since cooking energy use per dwelling depends in part on family size (which in Sweden is nearly 1/3 smaller in MFD than in SFD), gas stoves appear to consume less energy than electric, even after a corrrection is made for the efficiency difference between gas and electricity. Comparison of these two fuel uses would be deceptive. In fact, the difference is structural, because gas and electric stoves in the 1960s in Sweden came from two significantly differing dwelling populations. We have not always been able to disaggregate uses among dwelling types, so such biases in fuel type for heating, hot water, or cooking may give an artificial impression of different intensities.

4.6 Energy Types

We have attempted to aggregate different energy types in similar fashion among the countries, but for data reasons this has not always been possible. In some cases we distinguish among coke, coal, and wood, for example; otherwise these are aggregated as "solids". We count LPG as gas (except in the case of France and, for some years, Italy), kerosene separately or as oil. Gas as consumed is counted at its true calorific value; we do not concern ourselves with the fraction of consumption which is LPG, natural gas, or city gas.

District heating refers to large multi-block heating plants that may or may not generate electricity as well. They use mostly oil, but we count them as a primary energy "source". Single-block centrals, which often heat a few large apartment complexes and rarely provide electricity, are counted under their respective fuels in Swedish and German data.

We have not always been able to account for hot water use by energy type because of the uncertainty over hot water production in dishwashers and clothes washers. In most European countries, this hot water is prepared in the appliance, which is usually electric (exception: gas in France). Italy is the only country for which we have some estimates concerning the amount of energy used for hot water by these devices. In Sweden and Canada, most hot water comes from the central tank. We have ignored gas dryers and other minor gas appliances. Detailed analyses from gasworks in Sweden and the United Kingdom indicate that the gas consumption of these appliances is small compared to that for cooking. However, their gradual disappearance accounts in part for the reduced use of cooking gas in Sweden, since they are not recorded separately.

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II. TABLES OF RESIDENTIAL ENERGY USE

In this section we present our basic data on energy use in the residential sector of seven major OECD countries. Separate tables for several years are given for each country, with the most important data summarized in a time-series table at the end of each country section.

To facilitate reading of the tables and help explain their organization, we discuss some conventions that are common to all countries. Conventions and definitions that are particular to each country are explained in the introduction or notes of that country's section.

General Conventions

- All energy consumption data refer to end-use (building boundary) energy, unless otherwise stated.

- Primary energy per dwelling is given to indicate the size of electricity and district heating conversion losses. We convert from end-use energy using conversion efficiencies of 0.346 and 0.85, respectively. The electricity conversion factor is an average over the 1960-78 period for European OECD members, as given in IEA statistics.

- Heating consumption values are adjusted to normal climate, unless otherwise noted. Thus, the totals given in the tables do not exactly reflect actual energy consumption in a particular year. To calculate actual heating energy consumption, multiply the consumption given by the climate index.

- Many key indicators aggregate fossil fuels with electricity and district heat in order to provide a compact overview of a particular end-use (such as Heat/dw/DD and Hot Water/dw). To make comparison of these energy types acceptable, we convert electricity and district heat into fossil fuel-equivalent values. Thus, we ask: if a dwelling had been heated by fossil fuel instead of electricity, how much energy would have been used? (Note that this is not the same as "resource" or "primary" energy). For our purposes, a rough approximation is sufficient. As a standard convention, we divide electric and district heat intensities by a hypothetical fuel conversion efficiency of 65%. We make this adjustment only for heat and hot water.

Task 3: Energy Use Indicators

Terms and Definitions

- Dwellings means occupied dwellings, except: Sweden, where we count all heated dwellings (the non-occupancy rate is, however, low); Japan and the United Kingdom, where the number given refers to households.

- SFD (single-family dwellings) refers to detached one and two-family houses, row houses, and terraced houses, with some exceptions as described in country notes.

- DI/cap is personal disposable income per capita, given in each country's constant currency.

- Climate index is a measure of the relative severity of each year's climate, and thus, provides a rough indication of the relative need for heating.

- Appliances refers to uses of electric appliances, not including devices for supplying space heat, hot water, or primary cooking devices. The category includes lighting.

- Stock refers to the number of dwellings possessing a type of energy-using device, unless stated otherwise. (In some cases, it is possible to give only the number of devices).

- Unit cons. means unit consumption (sometimes called specific consumption), which refers to the amount of energy consumed per dwelling, unless stated otherwise.

- Heat/dw/DD means total end-use energy consumption for heating, with electricity and district heat expressed as fossil-fuel equivalent values, divided by the number of dwellings, divided by the normal number of heating degree-days.

- Appl elec/DI is total electricity consumption for appliances (in kWh) divided by total personal disposable income (in constant currency).

- HW/dw means total energy consumption for hot water, with electricity and district heat adjusted, divided by the number of dwellings with hot water facilities (often an estimate in earlier years).

- HW/cap (hot water energy consumption per capita) = HW/dw divided by persons/dwelling.

- HW/cap(tot) = total hot water consumption (with electricity and district heat adjusted) divided by the total population. In this indicator we see the effect of increasing saturation of hot water facilities.

- Elec/dw means total appliance electricity consumption divided by the total number of dwellings.

- Elec/cap (electricity per capita) = elec/dw divided by persons/dw.

Note: For a fuller discussion of terms, see the preceding section.

Totals in tables may not equal sum of components due to independent rounding.

CANADA

In the following tables we present detailed breakdowns of energy use in the residential sector in Canada for several years between 1960 and 1978.

The primary source for most of the data in the following tables is a model of Canadian residential energy use from 1960 to the present developed by Shell Canada. The Shell model offers detailed data on residential dwelling stock by dwelling type (single, multiple, apartments, and mobile homes), and on space heating energy consumption per dwelling, also by dwelling type. The model constructs total energy consumption by energy and dwelling type from estimates of consumption per dwelling . The Shell model attemps to capture the entire residential sector by including large apartment builldings that are usually left in the commercial sector. To achieve the greatest degree of accuracy for these estimates, each utility (gas and electric) was contacted to determine how multi-family and apartment dwellings were recorded in the consumption statistics published annually. Oil consumption statistics are from Shell.

The Shell model is less strong for end-uses other than space heating. Thus, we have constructed our own time-series for hot water and cooking based on discussions with electric and gas utilities. "Appliance" electricity is a residual derived by subtracting the derived values for electric heating, hot water, and cooking from actual total electricity consumption (adjusted by Shell to include apartment buildings).

Abbreviations used: $C -- Canadian dollars.

RESIDENTIAL ENERGY USE - CANADA

Year: 1978 Population: 23.5×10^6 Occ. Dw: 7.618×10^6

SFD: 64% DI/cap,($\$C_{70}$): 3563 Climate Index: 1.064

	Heat	Hot Water	Cooking	Appliances	Total
Oil,(PJ)	483	30.4	0.7	-	514
-Stock,(10^3)	3423	844	99	-	-
-Unit Cons,(GJ)	141	36.0	6.7	-	-
Gas,(PJ)	357	83.8	4.4	-	445
-Stock,(10^3)	2888	2652	653	-	-
-Unit Cons,(GJ)	124	31.6	6.7	-	-
Solids,(PJ)	12.3	1.0	0.9	-	14.2
-Stock,(10^3)	138	29	116	-	-
-Unit Cons,(GJ)	89.4	36.0	8.0	-	-
Elec,(PJ)	96.8	85.3	18.7	119	319
-Stock,(10^3)	1169	3947	6437	7618	-
-Unit Cons,(GJ)	82.8	21.6	2.9	15.6	-
TOTAL,(PJ)	950	201	24.7	119	1293
	(73%)	(15%)	(2%)	(9%)	(100%)

STRUCTURAL INDICATORS:		ENERGY USE INDICATORS:	
% dw oil heat	45	GJ/dw, end-use	170
% dw gas heat	38	GJ/dw, primary	249
% dw elec heat	15	% oil, end-use	40
% dw central heat	93	% elec, end-use	25
		Heat/dw/DD,(MJ)	28.7
		Appl elec/DI,(kWh/$C)	0.39

NOTES

Structure

Population and occupied dwellings are based on the census surveys taken mid-year in 1961, 1966, 1971, and 1976 (Statistics Canada). The census counts households, which are defined as a person or group of persons occupying one dwelling. The central heating fraction is also based on the census surveys, and includes all households with hot water, steam, and forced air furnaces, and electric heating (almost all of which is baseboard).

Disposable income per capita is based on the "National Income and Expenditure Accounts" (Statistics Canada), and is based on the sum of "Personal expenditure on consumer goods and services" and "Personal saving". Disposable income is converted to constant 1970 $C using the Consumer Price Index.

The climate index is from Shell. Normal = 4581 heating degree-days (base 18°C).

Heat

Energy use and heating equipment data in this and the following tables are based on a time-series of Canadian residential energy consumption developed by Shell Canada. (See introduction to Canada section). The Shell model disaggregates consumption for space heating by fuel for oil, natural gas, LPG, and "other". We have aggregated LPG with natural gas, and have described the Shell category "other" (which includes wood, coal, coke, and other) as "Solids".

Basic household data used in the Shell model are from the Statistics Canada Household Facilities and Equipment survey, with inconsistencies checked and adjusted accordingly. Household data have also been adjusted to include bulk-metered apartments.
[Heat/dw/DD, end-use = 26 MJ].

Hot Water and Cooking

We have developed our own time-series for hot water and cooking based on discussions with Canadian gas and electricity (Ontario Hydro) utilities. Unfortunately, the data necessary to accurately depict consumption over time do not exist. It seems, however, that hot water use has increased with time, due in part to the rise in hot water-using machines. Energy for cooking, on the other hand, has decreased, as more meals are eaten outside the home. Although only present unit consumption values are reasonably well-known, we believe the time-series given is a plausible estimate.

Hot water -- total consumption is derived from saturation data in the Shell model and the following estimates of unit consumption: for electric, consumption/dw increases linearly from 4000 kWh (14.4 GJ) in 1960 to 6000 kWh (21.6 GJ) in 1978; for gas, the same trend is assumed, with a gas company estimate for present use of 31.6 GJ extrapolated linearly to 22.2 GJ in 1961. We use the same trend for oil and solids, but assume a slightly lower efficiency (based on Shell).

Cooking -- total consumption is derived from saturation data from the annual Household Facilities and Equipment survey (Statistics Canada) and the following estimates of unit consumption: for electric, consumption/dw decreases linearly from 1200 kWh (4.3 GJ) in 1961 (based on a 1959 survey) to 800 kWh (2.9 GJ) in 1978; for gas and oil, the same trend is assumed, with a 1961 value of 10 GJ extrapolated linearly to 6.7 GJ in 1978. For solids, the same trend is used, with a lower efficiency. (Note: Oil cooking is insignificant (<2 PJ) in all years; solids cooking is significant as a fraction of total solids consumption only in the early 1960s).

Appliances

Energy consumption for electric appliances is derived by subtracting the calculated total for electric heating, hot water, and cooking from actual total residential electricity consumption, adjusted by Shell to include large apartment buildings. This category includes energy used for space cooling, which has seen modest penetration in the 1970s (present saturation is 11% for window units, 5% for central units; estimated energy use for cooling is <3% of electric appliance total for 1978). (Note: consumption of portable electric heaters and small cooking appliances are also included in this category).

Note: These notes apply for all year tables.

RESIDENTIAL ENERGY USE - CANADA

Year: 1976 Population: 23.0×10^6 Occ. Dw: 7.158×10^6

SFD: 64% DI/cap,($\$C_{70}$): 3589 Climate Index: 1.041

	Heat	Hot Water	Cooking	Appliances	Total
Oil,(PJ)	523	29.9	1.0	-	554
-Stock,(10^3)	3510	858	132	-	-
-Unit Cons,(GJ)	149	34.9	7.5	-	-
Gas,(PJ)	330	74.2	5.0	-	409
-Stock,(10^3)	2604	2424	673	-	-
-Unit Cons,(GJ)	127	30.6	7.5	-	-
Solids,(PJ)	13.0	1.0	0.8	-	14.8
-Stock,(10^3)	147	30	93	-	-
-Unit Cons,(GJ)	88.3	34.9	9.0	-	-
Elec,(PJ)	78.0	76.1	19.3	114	287
-Stock,(10^3)	896	3659	6040	7158	-
-Unit Cons,(GJ)	87.0	20.8	3.2	15.9	-
TOTAL,(PJ)	944	181	26.1	114	1265
	(75%)	(14%)	(2%)	(9%)	(100%)

STRUCTURAL INDICATORS:		ENERGY USE INDICATORS:	
% dw oil heat	49	GJ/dw, end-use	177
% dw gas heat	36	GJ/dw, primary	253
% dw elec heat	13	% oil, end-use	44
% dw central heat	92	% elec, end-use	23
		Heat/dw/DD,(MJ)	30.1
		Appl elec/DI,(kWh/$C)	0.38

RESIDENTIAL ENERGY USE-CANADA

Year: 1971 Population: 21.6×10^6 Occ. Dw: 6.034×10^6

SFD: 71% DI/cap,($\$C_{70}$): 2701 Climate Index: 1.015

	Heat	Hot Water	Cooking	Appliances	Total
Oil,(PJ)	540	22.4	1.8	-	564
-Stock,(10^3)	3479	708	214	-	-
-Unit Cons,(GJ)	155	31.7	8.3	-	-
Gas,(PJ)	263	51.9	8.9	-	322
-Stock,(10^3)	1964	1868	828	-	-
-Unit Cons,(GJ)	134	27.8	8.3	-	-
Solids,(PJ)	21.1	2.0	1.8	-	24.9
-Stock,(10^3)	240	64	184	-	-
-Unit Cons,(GJ)	87.9	31.7	10.0	-	-
Elec,(PJ)	29.9	56.7	16.8	79.5	183
-Stock,(10^3)	349	3017	4680	6034	-
-Unit Cons,(GJ)	85.5	18.8	3.6	13.2	-
TOTAL,(PJ)	854	133	27.3	79.5	1094
	(78%)	(12%)	(3%)	(7%)	(100%)

STRUCTURAL INDICATORS:		ENERGY USE INDICATORS:	
% dw oil heat	58	GJ/dw, end-use	181
% dw gas heat	33	GJ/dw, primary	239
% dw elec heat	6	% oil, end-use	52
% dw central heat	81	% elec, end-use	17
		Heat/dw/DD,(MJ)	31.5
		Appl elec/DI,(kWh/$C)	0.38

RESIDENTIAL ENERGY USE - CANADA

Year: 1966 Population: 20.0×10^6 Occ. Dw: 5.182×10^6

SFD: 70% DI/cap,($\$C_{70}$): 2321 Climate Index: 1.009

	Heat	Hot Water	Cooking	Appliances	Total
Oil,(PJ)	473	12.3	1.7	-	487
-Stock,(10^3)	3104	432	183	-	-
-Unit Cons,(GJ)	152	28.5	9.2	-	-
Gas,(PJ)	200	32.6	7.8	-	241
-Stock,(10^3)	1428	1305	851	-	-
-Unit Cons,(GJ)	140	25.0	9.2	-	-
Solids,(PJ)	47.0	5.1	4.3	-	65.4
-Stock,(10^3)	555	179	391	-	-
-Unit Cons,(GJ)	84.8	28.5	11.0	-	-
Elec,(PJ)	8.3	45.2	14.0	52.2	120
-Stock,(10^3)	96	2693	3492	5182	-
-Unit Cons,(GJ)	86.8	16.8	4.0	10.1	-
TOTAL,(PJ)	729	95.2	27.8	52.2	904
	(81%)	(11%)	(3%)	(6%)	(100%)

STRUCTURAL INDICATORS:		ENERGY USE INDICATORS:	
% dw oil heat	60	GJ/dw, end-use	174
% dw gas heat	28	GJ/dw, primary	218
% dw elec heat	2	% oil, end-use	54
% dw central heat	78	% elec, end-use	13
		Heat/dw/DD,(MJ)	30.9
		Appl elec/DI,(kWh/$C)	0.31

RESIDENTIAL ENERGY USE- CANADA

Year: 1961 Population: 18.2×10^6 Occ. Dw: 4.555×10^6

SFD: 74% DI/cap,($\$C_{70}$): 1835 Climate Index: 0.962

	Heat	Hot Water	Cooking	Appliances	Total
Oil,(PJ)	395	8.8	2.2	-	406
-Stock,(10^3)	2643	349	220	-	-
-Unit Cons,(GJ)	149	25.3	10.0	-	-
Gas,(PJ)	115	20.3	9.3	-	145
-Stock,(10^3)	860	915	932	-	-
-Unit Cons,(GJ)	134	22.2	10.0	-	-
Solids,(PJ)	84.2	7.5	8.9	-	101
-Stock,(10^3)	1029	297	740	-	-
-Unit Cons,(GJ)	81.8	25.3	12.0	-	-
Elec,(PJ)	1.8	31.6	10.6	36.5	80.5
-Stock,(10^3)	22	2136	2476	4555	-
-Unit Cons,(GJ)	81.5	14.8	4.3	8.0	-
TOTAL,(PJ)	596	68.2	31.0	36.5	732
	(81%)	(9%)	(4%)	(5%)	(100%)

STRUCTURAL INDICATORS:		ENERGY USE INDICATORS:	
% dw oil heat	59	GJ/dw, end-use	164
% dw gas heat	19	GJ/dw, primary	194
% dw elec heat	<1	% oil, end-use	55
% dw central heat	67	% elec, end-use	11
		Heat/dw/DD,(MJ)	28.6
		Appl elec/DI,(kWh/$C)	0.30

SUMMARY

RESIDENTIAL ENERGY USE IN CANADA 1960-1978

YEAR	1961	66	71	76	78
		STRUCTURE			
Occ. dw,(10^6)	4.555	5.182	6.034	7.158	7.618
SFD,(%)	74	70	71	64	64
Cen Ht,(%)	67	78	81	92	93
Cen Ht-SFD,(%)	-	-	-	62	62
Avg Size,(sq.m.)	97.4	98.3	97.6	98.7	99.4
Pers/dw	4.00	3.86	3.57	3.21	3.09
Hot water sat. (%)	81	89	94	97	98
DI/cap,($\$C_{70}$)	1835	2321	2701	3589	3563
		ENERGY TOTALS			
End-use (PJ)	732	904	1094	1265	1293
-fuel (PJ)	652	784	911	978	974
-elec (PJ)	80	120	183	287	319
-energy/dw (GJ)	164	174	181	177	170
Primary					
-energy/dw (GJ)	194	218	239	253	249
		HEAT			
Fuel,(PJ)	594	720	825	866	853
-sat.,(%)	99+	98	94	87	85
-oil/dw,(GJ)	149	152	155	149	141
-gas/dw,(GJ)	134	140	134	127	124
-solids/dw,(GJ)	81.8	84.8	87.9	88.3	89.4
Elec,(PJ)	1.8	8.3	29.9	78.0	96.8
-sat.,(%)	<1	2	6	13	15
-elec/dw,(GJ)	81.5	86.8	85.5	87.0	82.8
Total,(PJ)	596	729	855	944	950
Indicators:					
-heat/dw,(GJ)	131	141	144	138	132
-heat/dw/DD,(MJ)	28.6	30.9	31.5	30.1	28.7
-heat/dw/DD/m^2,(KJ)	294	314	323	305	289

RESIDENTIAL ENERGY USE IN CANADA 1960-1978, (continued)

YEAR	1961	66	71	76	78
		HOT WATER			
Fuel,(PJ)	36.6	50.0	76.3	105	115
-sat.(%)	34	37	44	46	46
-fuel/dw,(GJ)	23.5	26.1	28.9	31.8	32.7
Elec,(PJ)	31.6	45.2	56.7	76.1	85.3
-sat,(%)	47	52	50	51	52
-elec/dw,(GJ)	14.8	16.8	18.8	20.8	21.6
Total,(PJ)	68.2	95.2	133	181	201
Indicators:					
-HW/dw,(GJ)	23.0	25.9	28.9	31.9	33.0
-HW/cap,(GJ)	5.8	6.7	8.1	9.9	10.7
-HW/cap(tot),(GJ)	4.7	6.0	7.6	9.7	10.5
		COOKING			
Fuel,(PJ)	20.4	13.8	10.5	6.8	6.0
-sat.,(%)	42	29	21	13	12
-fuel/dw,(GJ)	10.8	9.7	8.6	7.7	6.9
Elec,(PJ)	10.6	14.0	16.8	19.3	18.7
-sat.,(%)	55	71	79	87	88
-elec/dw,(GJ)	4.3	4.0	3.6	3.2	2.9
Indicator:					
-energy/dw,(GJ)	6.8	5.4	4.5	3.6	3.2
		APPLIANCES			
Elec,(PJ)	36.5	52.2	79.5	114	119
(TWh)	10.1	14.5	22.1	31.6	32.9
-elec/dw,(GJ)	8.0	10.1	13.2	15.9	15.6
(kWh)	2225	2800	3665	4410	4320
Indicators:					
-elec/cap,(kWh)	555	725	1025	1375	1400
-elec/DI,(kWh/$C)	0.30	0.31	0.38	0.38	0.39

NOTES

Most of the above information is taken from the year tables. Single-family dwelling fraction is based on the census surveys, and consists of the census categories "single detached" and "single attached". The fraction of centrally-heated single-family dwellings is based on mid-year estimates from the Household Facilities and Equipment survey.

Historical changes in the average size of Canadian dwellings are not well-known. The average size of the present (1978) stock is based on research conducted by Scanada Consultants.[1] Most experts believe that the average size has changed little since 1960. The increasing size of single-family houses has been compensated by the greater proportion of townhouses and apartments built in the 1970s. We have estimated average size for the other years by assuming that changes in average size are proportional to changes in the average number of rooms per dwelling, as reported in Statistics Canada's yearly Household Facilities and Equipment survey. (Rooms/dwelling increased from 5.35 in 1961 to 5.40 in 1966, then fell to 5.36 in 1971, rising to 5.46 in 1978). This assumes that the average size of rooms has remained constant.
Persons per dwelling is from Shell.

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FRANCE

Some statistics on energy consumption in the residential sector in France were collected since the early 1960s, when the "Centre d'Etudes Regionales sur l'Energie"(CEREN) was formed. This research group -- started privately and then co-managed by the main energy institutions -- has since organized the collection of energy demand data with regular surveys of household energy consumption. The importance of this structure was discovered in its entirety only later on, when the French government decided to establish an agency responsible for RD&D in energy conservation, the "Agence pour les Economies d'Energie"(AEE). The CEREN already had most of the information necessary to effectively implement some energy conservation programs.

The information available -- either officially or by private means -- is thus all related originally to the CEREN periodical surveys. The data that has been gathered from various sources shows in fact only slight differences, reflecting some "correction factors" applied to the original CEREN reports, with the purpose of adapting it to specific tasks.

For 1978, a more detailed and careful analyis of energy consumption by end-use has been used than was available for earlier years. There are evident inconsistencies between the 1978 data, which is viewed as more reliable, and earlier years. Thus, even rough comparisons should be made with caution.

In adapting the available data to our breakdown, a double-checking procedure has been necessary because of the different type of "correction factors" that are applied by these agencies. Electricity is presented in the French reports in terms of primary energy, considering a conversion factor that includes the efficiency of electricity production from the different sources. This factor varies slightly every year (from 0.389 to 0.392 for the years considered). In these tables, electricity is presented as end-use energy.

The climate index from AEE has been here based on the average value for France (base 18 C) of 2200 DD (1975 value, confirmed by our IEJE source).

The energy types used in the tables are defined as follows:
Oil includes liquid fuels and liquid petroleum gas (LPG).
Gas is considered "from pipeline" whether natural or man-made.
Wood includes all plant matter. Coal includes coke.

Appliance energy use is defined in the French sources as "electricite specifique" and includes uses that cannot be substituted by other sources. However, hot water prepared in dish- and clothes-washers does not appear to be excluded from the computation, although appliances that make their own hot water electrically seem to be in the minority of the stock.

Note: Beginning in 1973, the figure under Heat given in parentheses refers to centrally-heated dwellings; in many cases only this information is available.

The following abreviations are used in this section:
AEE -- Agence pour les Economies d'Energie;
EdF -- Electricite de France;
GdF -- Gaz de France;
CEREN -- Centre d'Etudes Regionales sur l'Energie;
UNIPEDE -- Union des Producteurs et Distributeurs d'Electricite.
EUROSTAT -- Statistical Office of the European Economic Community, Brussels.
IEJE -- Institut Economique et Juridique de l'Energie, Universite de Grenoble.

RESIDENTIAL ENERGY USE - FRANCE

Year: 1978 Population: 53.2×10^6 Occupied Dw: 18.6×10^6

SFD: 49% DI/cap,FF_{70}: 13710 Climate Index: 1.01

	Heat	Hot Water	Cooking	Appliances	Total
Oil,PJ	682	84.9	52	-	819
-Stock,10^3	10015	5720	7965	-	
-Unit Cons,GJ	68.1(a)	14.9	6.5	-	
Gas,PJ	205	58.5	33	-	297
-Stock,10^3	3720	5560	6490	-	
-Unit Cons,GJ	55.1(b)	10.6	5.1	-	
Wood,PJ	0.8	0.4	1.3	-	2.5
-Stock,10^3	36	70	38	-	
-Unit Cons,GJ	22.2(c)	6.3	-	-	
Coal,Coke,PJ	84	3.3	44	-	131
-Stock,10^3	2370	165	1670	-	
-Unit Cons,GJ	35.3(d)	20.3	-	-	
Elec,PJ	43	35.8	14.8	99.2	193
-Stock,10^3	4380	4070	3450	18600	
-Unit Cons,GJ	9.8(e)	8.8	4.3	5.3	
Dist Ht,PJ	35.7	8.9	-	-	45
-Stock,10^3	523	425	-	-	
-Unit Cons,GJ	68(f)	21.3	-	-	
TOTAL,PJ	1051	192	145	99	1487
	(71%)	(13%)	(10%)	(7%)	(100%)

STRUCTURAL INDICATORS:		ENERGY USE INDICATORS:	
% dw oil heat	46	GJ/dw,end-use	80
% dw elec heat	9	GJ/dw,primary	100
% dw dist heat	3	% oil, end-use	55
% dw other	42	% elec, end-use	13
% dw central heat	60	Heat/dw/DD,MJ	26.1
		Appl elec/DI,kWh/FF_{70}	0.038

NOTES

This "balance" has been constructed mostly from the available information and previous computations of CEREN, AEE, EdF and Ministere de l'Environnement, along with personal communications from Gaz de France.

Heat includes central and non-central heating systems in all occupied dwellings (calculated at mid-year by AEE.) GdF also gives estimates of consumption for second homes and vacant dwellings that we have not considered (for consistency with other countries).
The unit consumption figures are an average for each energy type but tend to vary considerably among different dwelling types. However, we did not split SFD and MFD in the tables because the necessary disagregation of non-central systems by dwelling type was not available. This variation of unit consumption ranges as follows:
(a) for oil, from 117 GJ for central heated SFD to 10 GJ for stoves;
(b) for gas, from 83 GJ to 7 GJ (as above);
(c) for wood, from 59 GJ to 8 GJ (as above);
(d) for coal, from 113 GJ to 12 GJ (as above);
(e) for electricity, from 39 GJ to 4 GJ (as above);
(f) for district heat, from 103 GJ for SFD to 64 GJ for MFD. (Note: the split of sources for district heating is: oil -- 63%, natural gas -- 12%, coal -- 13%, others (including solid waste) -- 12%).

The saturation of different energy types for heating has been calculated exluding all auxiliary room heaters ("appareils de chauffage d'appoint" and "cuisinieres chauffantes"), although these systems could be the only heating system in many dwellings.

Heat/dw/DD is an average figure over a considerably varied stock of systems. We have assumed that all 18.6 million dwellings are heated in some way. Considering that we have, on average, more than one heating system per dwelling, we can calculate a per-system value of 22.7 MJ/DD.

Hot Water can be from central heating systems or from autonomous water heaters. For oil and gas these two sources are split almost equally (56% from central systems), although the unit consumption is considerably different (18.5 GJ for hot water from central systems, 5.4 for hot water from heaters). All coal and district heating hot water is connected with central systems; all wood and electric hot water is from small heaters.

Cooking devices using LPG comprise 92% of the "oil" cookers. Their unit consumption is 5.2 GJ. The rest of the "oil" cookers have a much higher unit consumption of 20 GJ. Most of the consumption of solid-fueled devices should be counted as space heating, since many of these devices -- called "cuisinieres chauffantes" are the only heating system in these houses. Cooking tables with electricity and gas or LPG are split equally between electricity and the complementary fuel.

RESIDENTIAL ENERGY USE - FRANCE

Year: 1973 Population: 52.1×10^6 Occupied Dw: 17.3×10^6

SFD: 48% DI/cap,FF_{70}: 12325 Climate Index: 1.07

	Heat	Hot Water	Cooking	Appliances	Total
Oil,PJ	816(690)	75	33	-	924
-Stock,10^3	NA(5495)	5900	NA	-	
-Unit Cons,GJ	NA(126)	12.7	NA	-	
Gas,PJ	124(115)	42	33	-	199
-Stock,10^3	2515(1515)	4750	5500	-	
-Unit Cons,GJ	49(76)	8.8	6	-	
Wood,PJ	21(4)	-	-	-	21
-Stock,10^3	NA	-	-	-	
-Unit Cons,GJ	NA	-	-	-	
Coal,Coke,PJ	158(68)	4.2	4.2	-	166
-Stock,10^3	NA(740)	240	NA	-	
-Unit Cons,GJ	NA(92)	16.2	NA	-	
Elec,PJ	11(2.5)	21	6.5	70	109
-Stock,10^3	NA(65)	3250	1010	17300	
-Unit Cons,GJ	NA(38)	6.6	6.4	4.0	
-Dist Heat,PJ	18	-	-	-	18
-Stock,10^3	260	-	-	-	
-Unit Cons,GJ	68(est)				
TOTAL,PJ	1148	143	77	70	1438
	(80%)	(10%)	(5%)	(5%)	(100%)

STRUCTURAL INDICATORS:		ENERGY USE INDICATORS:	
% dw oil central heat	33	GJ/dw,end-use	83
% dw elec central heat	<1	GJ/dw,primary	95
% dw dist heat	1.5	% oil, end-use	64
% dw other cent ht	14	% elec, end-use	8
% dw central heat	48	Heat/dw-DD,MJ	30.6
		Appl elec/DI,kWh/FF_{70}	0.030

NOTES

Basic data are from recent documents of AEE and CEREN.

Heating energy consumption refers to all systems in occupied dwellings. These figures have been derived by excluding the estimated consumption of secondary and unoccupied homes from what AEE calls "chauffage autre", which includes "appareils divises" and "residences secondaires". We have assumed the same consumption rate for these unoccupied residences for the different energy types as for 1978, and applied it to the 1973 stock of "residences secondaires" as well. (The correction is in any case a minor factor).
The figures in parentheses refer to central heating, for which complete series of consumption and saturation are available, as estimated by CEREN. The number of dwellings heated with the various energy types is given for centrally-heated dwellings only (in parentheses) because these were the only reliable data available.

District heating is considered central. Total consumption is estimated using the 1978 unit consumption value of 68 GJ/dw. District heat is mixed in with the other fuels in our sources, according to the primary fuel used to supply the district heat. We have removed it from the other fuels using the above unit consumption estimate, since we know how many district-heated dwellings had oil, gas, or coal as a primary source (135000, 25000, and 100000, respectively).
The number of non-central heating systems for gas is available from GdF. These systems are all fueled with natural gas and city gas. LPG (57 PJ) is included in "oil" because its share was not available.

Hot water consumption derived from AEE data and GdF. Source for data on the shares of the different energy types is the AEE report issued in 1977.

Cooking energy use is derived as hot water from AEE, GdF, and EdF for electric cookers. UNIPEDE estimates have been used for the gas and electric share. Energy consumption of cookers that use more than one fuel has been split between the different types.

Total LPG = 68 PJ (included in oil). Primary to end-use conversion factor for electricity is 2.56 (AEE).

RESIDENTIAL ENERGY USE-FRANCE

Year: 1968 Population: 50.1×10^6 Occupied Dw: 15.8×10^6

SFD: 51% DI/cap,FF_{70}: 9530 Climate Index: 1.01

	Heat	Hot Water	Cooking	Appliances	Total
Oil,PJ	NA	NA	NA	-	557
-Stock,10^3	NA(2923)	NA	NA	-	
-Unit Cons,GJ					
Gas,PJ	NA	NA	NA	-	101
-Stock,10^3	NA(585)	NA	NA	-	
-Unit Cons,GJ					
Coal,Coke,Wood,PJ	NA	NA	NA	-	358
-Stock,10^3	NA(1390)	NA	NA	-	
-Unit Cons,GJ					
Elec,PJ	1.2(0)	9.7	2.4	49.3	62
-Stock,10^3	NA(0)	NA	790	15800	
-Unit Cons,GJ	-	-	3	3.1	
Dist Ht,PJ	NA	-	-	-	NA
-Stock,10^3	111	-	-	-	
-Unit Cons,GJ					
TOTAL,PJ	863	107	59	49	1078
	(80%)	(10%)	(5%)	(5%)	(100%)

STRUCTURAL INDICATORS:		ENERGY USE INDICATORS:	
% dw oil central heat	18.5	GJ/dw,end-use	68
% dw elec central heat	0	GJ/dw,primary	76
% dw dist heat	0.7	% oil, end-use	52
% dw other cen ht	12.5	% elec, end-use	6
% dw central heat	32	Heat/dw/DD,MJ	24.4
		Appl elec/DI,kWh/FF_{70}	0.029

NOTES

The only information given for this year by the CEREN and the agencies that rely on their statistics consists in estimates of the total primary energy consumption of all residences by end-use, and in a survey of the stock of centrally-heated dwellings by primary heating fuel. We were unable to obtain any detail on the breakdown by end-use and equipment for the entire housing stock.

"All residences" means that "principales" and "secondaires" are aggregated. For consistency with later years, we should split the heating consumption as we have done for 1973, but in this case we did not have the subdivision by fuels.

All sources show hot water and cooking aggregated. We have split these end-uses applying the fixed rate of 5.5% of total primary energy for cooking, as mentioned in the AEE's more recent document. This estimate should be viewed as rough.
The hot water saturation given in the literature is 51% of the occupied dwellings; this number may be low.

The correction of the totals from primary (given by AEE) to total end-use electricity was made The estimate of electric cooking consumption was derived from UNIPEDE, who claim that 5% of cookers were electric throughout the 1960s, with an average unit consumption of 3 GJ per dwelling. Electric heating and hot water have been estimated from past trends.

Fuel totals have been gathered from many inconsistent sources. We give priority to the more reliable sources -- INSEE and EdF for the electricity and GdF for gas -- although we have also examined estimates from EUROSTAT and Shell France. The major differences in these sources are related to oil consumption, for which we have derived a consistent figure from EUROSTAT data (used also by Shell). Estimates for solid fuels, for example, differ by ~7%.

RESIDENTIAL ENERGY USE - FRANCE

Year: 1962 Population: 46.4×10^6 Occupied Dw: 14.6×10^6

SFD: 55% DI/cap,FF_{70}: 7600 Climate Index: 1.14

	Heat	Hot Water	Cooking	Appliances	Total
Oil,PJ	NA	NA	NA	-	192
-Stock,10^3	NA(905)	NA	NA	-	
-Unit Cons,GJ					
Gas,PJ	NA	NA	NA	-	57
Units,10^3	NA(131)	NA	NA	-	
-Unit Cons,GJ					
Coal,Coke,Wood,PJ	NA	NA	NA	-	337
-Stock,10^3	NA(1767)	NA	NA	-	
-Unit Cons,GJ					
Elec,PJ	0.5(0)	8.7	2.2	28.0	39
-Stock,10^3	NA(0)	1600	730	14600	
-Unit Cons,GJ		5.4	3.0	1.9	
Dist Ht,PJ	NA	-	-	-	-
-Stock,10^3	102	-	-	-	-
-Unit Cons,GJ	NA	-	-	-	-
TOTAL,PJ	514	48	35	28	625
	(82%)	(8%)	(6%)	(4%)	(100%)

STRUCTURAL INDICATORS:		ENERGY USE INDICATORS:	
% dw oil central heat	6	GJ/dw,end-use	42
% dw elec central heat	0	GJ/dw,primary	48
% dist heat	0.7	% oil, end-use	31
% dw other cen ht	13	% elec, end-use	6
% dw central heat	20	Heat/dw/DD,MJ	16.0
		Appl elec/DI,kWh/FF_{70}	0.022

NOTES

As for previous years, the data available refers to the total primary energy by end-use and to the central heating shares by energy types. Total consumption by end-use has been converted from primary energy as for 1968, and includes secondary and unoccupied homes (estimated heat consumption: 14 GJ/dw). Since district heating is counted within the primary fuels, disaggregation has not been possible.

Saturation for gas and electric water heaters are from INSEE survey of domestic appliances. The figure for the electric heaters allows a more accurate estimate of the electric consumption and therefore of the end-use energy delivered for this use.

Electric cooking from UNIPEDE as for 1968.

Total fuels have been derived as for 1968 from various sources. Oil total is from INSEE and includes LPG (34 PJ). A higher estimate was derivable from EUROSTAT statistics (226 PJ) but for this year this source seems to be largely overestimating all the fuels, especially if we want to fit the fuels totals in the recent AEE estimates. Gas is from the recent GdF series and is close to the INSEE and EUROSTAT figures. Electricity is somewhat higher than the other sources available (EUROSTAT, 27 PJ; INSEE, 32PJ), but these figures were basically inconsistent with the AEE figure for specific electricity, to which we give priority.

The solid fuel figure has been derived by exclusion. The only other figure we found was considerably higher (EUROSTAT, 509 PJ) but it refers to a much higher total also (806 PJ).

Share of heated dwellings per fuel, and heating consumption per degree day as for previous years.

SUMMARY

RESIDENTIAL ENERGY USE IN FRANCE 1960-1978

YEAR	1962	68	73	78
		STRUCTURE		
Occupied Dw, 10^6	14.57	15.78	17.30	18.60
SFD,%	55	51	48	49
Cen Ht,%	20	32	48	60
Cen Ht-SFD,%	39	34	42	44
Avg Size,sq.m.	65	68	72	77
Pers/dw	3.28	3.17	3.08	2.92
Hot water sat.,%	NA	51	63	86
DI/cap, FF_{70}	7600	9530	12325	13710
Climate Index	1.14	1.01	1.07	1.01
		ENERGY TOTALS		
End-use,PJ	625	1078	1438	1487
-fuel,PJ	586	1016	1311	1294
-elec,PJ	39	62	109	193
-energy/dw,GJ	42	68	83	80
Primary				
-energy/dw,GJ	48	76	95	100
		HEAT		
Fuel,PJ	513	862	1119	972
-stock, 10^6	NA	NA	NA	16.14
-fuel/dw,GJ	NA	NA	NA	60.2
Elec,PJ	0.5	1.2	11	43
-sat.,%	NA	NA	NA	24
-elec/dw,GJ	NA	NA	NA	9.8
Dist Heat,PJ	NA	NA	18	35.7
-sat.,%	<1	<1	1.5	2.8
-dist heat/dw,GJ	NA	NA	68	68
Total,PJ	514	863	1148	1051
Indicators:				
-heat/dw,GJ	35.2	54.9	67.3	58.8
-heat/dw/DD,MJ	16.0	24.4	30.6	26.1
-heat/dw/DD/m^2,KJ	247	365	425	347

RESIDENTIAL ENERGY USE IN FRANCE 1960-1978 (continued)

YEAR	1962	68	73	78
	HOT WATER			
Fuel,PJ	39	97	122	147
-stock,10^6	NA	NA	10.05	11.51
-fuel/dw,GJ	NA	NA	12.1	12.8
Elec,PJ	8.7	9.7	21.4	35.8
-sat.,%	11	NA	19	22
-elec/dw	5	NA	6.6	8.8
Dist Heat,PJ	NA	NA	NA	8.9
-sat.,%	NA	NA	NA	2
-dist heat/dw	NA	NA	NA	21.3
Total,PJ	48	107	143	192
Indicators:				
HW/dw,GJ	7-8(est)	13.9	14.1	13.5
HW/cap,GJ	2.2-2.5	4.4	4.6	4.6
HW/cap(tot),GJ	1.1	2.2	3.0	3.8
COOKING				
Fuel,PJ	33	57	70	130
-stock,10^6	13.9	15.0	16.3	16.2
-fuel/dw,GJ	2.4	3.8	4.3	5.9
Elec,PJ	2.2	2.4	6.5	14.8
-stock,10^3	730	790	1010	3450
-elec/dw,GJ	3	3	6.4	4.3
Total,PJ	35	59	77	145
Indicator:				
-energy/dw,GJ	2.4	3.8	4.4	5.9
	APPLIANCES			
Elec,PJ	28.0	49.3	69.5	99.2
TWh	7.8	13.7	19.3	27.6
-elec/dw,GJ	1.9	3.1	4.0	5.3
kWh	535	865	1115	1470
Indicators:				
-elec/cap,kWh	167	273	371	519
-elec/DI,kWh/FF_{70}	0.022	0.029	0.030	0.038

NOTES

These data are assembled from the detailed year tables. Recall that 1978 data are not strictly comparable with earlier years.

"Dwellings" refers to occupied dwellings (residences principales). The share of centrally-heated SFD is derived from INSEE surveys for 1962 and 1968, and from AEE for the other years. Average dwelling area is derived from INSEE for 1973 (only year for which a detailed analysis per housing type is available) and estimated for the other years on the basis of the average number of rooms in each type of dwelling.

Disposable income is corrected to 1970 values dividing by the Consumer Price Index.

"Fuel" includes oil, solids, gas, and the district heating sources -- except for 1978, for which district heat energy use was available in detail, and 1973, for which district heat could be plausibly estimated. The "fuel" value for 1978 under "Energy Totals" includes 45 PJ of district heat.

Heat/dw uses all occupied dwellings in the denominator.

For hot water fuel, we give the number of systems, which is not the number of dwellings with fuel hot water systems. HW/dw uses the values given for the percentage of dwellings with hot water facilities. It appears that the 1968 and 1973 values may be low. Saturation for 1962 was estimated at ~50%.

For cooking we give the number of systems, not the dwelling saturation. Fuel cooking for 1962, 1968, and 1973 has been derived by exclusion of the known electric share, assuming one cooking table per dwelling. For 1978 we have derived from GdF a rate of 1.05 cooking devices per dwelling. The 1978 indicator is calculated by excluding the solids' consumption and share, which include the space heating of the "cuisinieres chauffantes" (see 1978 notes).

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GERMANY

In the following tables we present detailed breakdowns of energy use in the residential sector in Germany for several years between 1960 and 1978. The major source for the housing and energy consumption data is a detailed study by P.H. Suding of the University of Koln, prepared for the German Ministry of the Treasury and the Ministry for Research and Technology. Prior to receiving this study, we had collected and analyzed many of the data sources used by Suding, as well as others.

For ease in reading the tables, note the following:

-- For electric heating, two numbers are given, separated by a slash. The first number refers to electric storage- heating ("Speicherheizung"), which is a primary heating system; the second to electric portable room-heaters ("Direktheizung"), which are quite common in dwellings with various principle heating systems.

-- For hot water, two numbers are given. The first refers to central heating; the second to point-of-use water heaters, which are often used in kitchens and bathrooms.

-- For cooking, two numbers are given, with one in parentheses. The first number refers to the total number of ovens. In many dwellings, old ovens are kept and used part of the time (often for space heating of the kitchen). The second number is an estimate of the number of ovens that are the sole oven in the dwelling.

-- Abbreviations used:
DM -- Deutsche Mark.
HEA -- Hauptberatungsstelle fur Elektrizitatsanwendung (Central Advisory Bureau for Electrical Application).
EWI -- Energiewirtschaftliches Institut, Universitat Koln

RESIDENTIAL ENERGY USE - GERMANY

Year: 1978 Population: 61.3×10^6 Occ. Dw: 23.9×10^6

SFD: 49% DI/cap,(DM_{70}): 8982 Climate Index: 1.013

	Heat	Hot Water	Cooking	Appliances	Total
Oil,(PJ)	1108	85.3	-	-	1193
-Stock,(10^3)	12595	7576/1000	-	-	-
-Unit Cons,(GJ)	88.0	10.3/7.3	-	-	-
Gas,(PJ)	305	46.3	11.0	-	362
-Stock,(10^3)	4732	2008/3227	5019	-	-
-Unit Cons,(GJ)	64.4	9.9/8.2	2.2	-	-
Solids,(PJ)	124	20.4	14.1	-	159
-Stock,(10^3)	3035	239/1806	3585(1434)	-	-
-Unit Cons,(GJ)	41.0	14.1/9.1	3.9	-	-
Elec,(PJ)	61.8/14.9	78.0	29.4	105	289
-Stock,(10^3)	1673/7850	10516	17447	23900	-
-Unit Cons,(GJ)	36.9	7.4	1.7	4.4	-
Dist Ht,(PJ)	57.8	8.8	-	-	66.6
-Stock,(10^3)	1864	1219	-	-	-
-Unit Cons,(GJ)	31.0	7.2	-	-	-
TOTAL,(PJ)	1672	239	54.5	105	2070
	(81%)	(11%)	(3%)	(5%)	(100%)

STRUCTURAL INDICATORS:		ENERGY USE INDICATORS:	
% dw oil heat	53	GJ/dw, end-use	86.6
% dw elec heat	7	GJ/dw, primary	110
% dw gas heat	20	% oil, end-use	58
% dw dist heat	8	% elec, end-use	14
% dw central heat	66	Heat/dw/DD,(MJ)	20.2
		Appl elec/DI,(kWh/DM)	0.053

NOTES

The major source for our Germany presentation is a comprehensive, just-completed work by P.H. Suding.[1] This report gives a time-series of residential energy consumption by energy type and end-use from 1960 to 1978. Thus, the notes presented here apply to most of the other years as well. In the notes for those tables we present changes or additions as necessary.

Structure

Population: Statistisches Jahrbuch; refers to total population, not just population in dwellings.

Disposable income per capita: Statistisches Jahrbuch; converted to 1970 Deutsche Mark using the Consumer Price Index.

Occupied dwellings: Suding -- based on oil company market research as reported by Holm, and Schmitt and Schiffer, checked with results of the official 1% housing survey. These values (as well as those in the following tables) are felt to be more reliable than the official housing statistics, which tend to underestimate the removal of dwellings from the housing stock.

Climate index: Esso; based on annual average degree-days for nine cities compiled by the Deutsche Wetterdienst. Normal = 3613 DD. Note -- in the German system, DD = (20 ^{o}C - daily average) x (# of heating days), where heating days are only counted when the average daily temperature is 15 ^{o}C or below.

Central heating fraction: The sources cited under "Occupied dwellings" were used for heating equipment data. The fraction given includes district-heated dwellings. Electric storage heating is not considered central.

Heat

Total consumption: Suding -- oil, solids, and district heat are from Arbeitsgemeinschaft Energiebilanzen; gas is from the Statistischer Bericht des Referats Gaswirtschaft im Bundesministerium fuer Wirtschaft; electric storage heating is from the Statistischer Bericht des Referats Elektrizitaetswirtschaft; consumption of electric portable heaters is derived by Suding from HEA saturation data and his estimate of unit consumption (which ranges from 534 kWh/yr in 1978 to 259 kWh/yr in 1960).

Stock: See note for central heating.

Unit consumption: derived from total consumption and stock for each energy type. Note -- for electric heating, unit consumption refers only to storage heaters, not to portable heaters. [Heat/dw/DD, end-use = 19.4 MJ]

Hot Water

Total consumption: Suding -- derived from stock and unit consumption (est.); for fossil fuels and district heat, total includes central units (connected to a central heating system), bathroom and kitchen units, and (for solids) washkettles for clotheswashing (the saturation of which declined from ~20% in 1960 to ~2% in 1978); for electricity, total includes bathroom and kitchen units, clotheswashers, and dishwashers.

Stock: Suding -- for central units, based on estimates of the fraction of central heating systems that also provide hot water, HEA (Muller/Schulz), (refers to number of dwellings); for fuel-burning bathroom (oil, gas, and solids) and kitchen (gas only) units, also HEA (Muller/Schulz), (refers to number of units, not dwellings); for electric bathroom and kitchen devices, HEA, (refers to the number of dwellings with at least one electric hot water heater). Note -- the stock of electric clothewashers and dishwashers is not presented in the table, but the energy use of these devices is included in total consumption; saturation of clothewashers rose from 29% in 1960 to 89% in 1978, for dishwashers from almost zero in 1960 to 17% in 1978.

Unit consumption: Suding -- based on estimates of daily hot water use per person, HEA (Muller/Schulz), checked with other estimates of annual hot water use per household. the unit consumption given for electric hot water is for a dwelling with bathroom and kitchen units and a clotheswasher (it is not an average of all dwellings); for oil-, gas-, and solids-burning and district heat central units the unit consumption values (bathroom plus kitchen) used for electricity were multiplied by a factor of 1.8, 1.6, 2.0, and 1.23, respectively; for oil- (bathroom only), gas- (kitchen and bathroom), and solids- (bathroom only) burning bathroom and kitchen units, the appropriate electricity values were multiplied by 1.7, 1.4, and 2.14, respectively (conversion factors based on Geiger and Wegner); a value of 350 kWh/yr is used for electric clotheswashers, 670 kWh/yr for dishwashers, and 2.3 GJ/yr for solids-burning washkettles.

Cooking

Total consumption: Suding -- derived from stock and unit consumption; adjusted to reflect actual total residential consumption by fuel.

Stock: Suding -- for gas and electricity, from HEA; solids extrapolated from 1960s values.

Unit consumption: Suding -- for gas, from Energiewirtschaftliches Institut (EWI); for solids, estimates vary greatly (2.9-5.8 GJ/yr), Suding uses the higher value because coal ovens are often used for kitchen heating; it is assumed that partially used solids-burning ovens consume half as much (2.9 GJ/yr); for electricity, based on EWI, HEA, and penetrations of other kitchen devices. The unit consumption values given reflect the total stock.

Electric Appliances

Total consumption: Suding -- from the Statistischer Bericht des Referats fuer Elektrizitaetswirtschaft, which gives total electricity use with and without electric storage heating; total given is the residual after derived totals for portable heaters, hot water, and cooking are subtracted from total electricity without storage heating; includes refrigerator, freezer, television, lights, clothesdryer, and other.

Stock: assumes all dwellings have some electric appliances.

Unit consumption: total consumption divided by stock.

Note: "Appl elec/DI" is electricity consumption for appliances, in kWh, divided by total personal disposable income, in constant DM. The "Appliances" category does not include electric ranges or devices used for heating and hot water.
"% dw elec heat" refers to electric storage-heating; many dwellings that are primarily fuel-heated use portable electric heaters as well.

RESIDENTIAL ENERGY USE - GERMANY

Year: 1975 Population: 61.8×10^6 Occ. Dw: 22.6×10^6

SFD: 48+% DI/cap,(DM_{70}): 8012 Climate Index: 0.958

	Heat	Hot Water	Cooking	Appliances	Total
Oil,(PJ)	1016	67.3	-	-	1083
-Stock,(10^3)	11571	5853/1400	-	-	-
-Unit Cons,(GJ)	87.8	9.9/6.7	-	-	-
Gas,(PJ)	204	38.0	12.9	-	255
-Stock,(10^3)	3480	1220/3503	5876	-	-
-Unit Cons,(GJ)	58.7	8.9/7.8	2.2	-	-
Solids,(PJ)	181	28.4	20.2	-	229
-Stock,(10^3)	4769	407/2650	5424(1356)	-	-
-Unit Cons,(GJ)	37.8	10.9/8.5	3.7	-	-
Elec,(PJ)	49.5/12.4	68.4	25.0	91.4	247
-Stock,(10^3)	1288/7680	9944	15368	22600	-
-Unit Cons,(GJ)	38.4	6.9	1.6	4.0	-
Dist Heat,(PJ)	54.5	6.1	-	-	60.6
-Stock,(10^3)	1492	904	-	-	-
-Unit Cons,(GJ)	36.5	6.7	-	-	-
TOTAL,(PJ)	1517	208	58.1	91.4	1875
	(81%)	(11%)	(3%)	(5%)	(100%)

STRUCTURAL INDICATORS:		ENERGY USE INDICATORS:	
% dw oil heat	51	GJ/dw, end-use	83.0
% dw gas heat	15	GJ/dw, primary	104
% dw elec heat	6	% oil, end-use	58
% dw dist heat	7	% elec, end-use	13
% dw central heat	57	Heat/dw/DD,(MJ)	19.3
		Appl elec/DI,(kWh/DM)	0.051

NOTES

Structure

See notes for 1978 table, except: Dwellings and Central heating fraction; Suding, based on market research by Deutsche BP AG, Deutsche Shell AG, and Esso AG.

Heat

See notes for 1978 table, except: Stock; Suding, see note for Dwellings. Heat/dw/DD, end-use = 18.6 MJ

Hot Water

See notes for 1978 table, except: Stock; Suding, for central units, based on conversations with market research experts, for oil- and solids-burning bathroom and kitchen units, values interpolated from other years.

Cooking

See notes for 1978 table.

Electric Appliances

See notes for 1978 table.

Note: these notes apply for the 1972 table as well.

RESIDENTIAL ENERGY USE-GERMANY

Year: 1972 Population: 61.7×10^{6d} Occ. Dw: 21.4×10^{6}
SFD: 48% DI/cap,(DM_{70}): 7686 Climate Index: 1.037

	Heat	Hot Water	Cooking	Appliances	Total
Oil,(PJ)	985	45.3	-	-	1031
-Stock,(10^3)	10358	4023/1220	-	-	-
-Unit Cons,(GJ)	95.1	9.4/6.1	-	-	-
Gas,(PJ)	136	30.2	14.2	-	180
-Stock,(10^3)	2333	578/3424	6206(5992)	-	-
-Unit Cons,(GJ)	58.2	8.6/7.4	2.3	-	-
Solids,(PJ)	274	30.0	24.0	-	328
-Stock,(10^3)	6698	514/2800	7062(1070)	-	-
-Unit Cons,(GJ)	40.9	10.7/7.7	3.4	-	-
Elec,(PJ)	32.7/14.0	57.8	21.0	73.2	199
-Stock,(10^3)	856/7280	9844	13482	21400	-
-Unit Cons,(GJ)	38.2	6.5	1.6	3.4	-
Dist Ht,(PJ)	50.1	3.8	-	-	53.9
-Stock,(10^3)	1156	599	-	-	-
-Unit Cons,(GJ)	43.3	6.4	-	-	-
TOTAL,(PJ)	1492	167	59.2	73.2	1792
	(83%)	(9%)	(3%)	(4%)	(100%)

STRUCTURAL INDICATORS:		ENERGY USE INDICATORSe:	
% dw oil heat	48	GJ/dw, end-use	83.7
% dw gas heat	11	GJ/dw, primary	102
% dw elec heat	4	% oil, end-use	58
% dw dist ht	5	% elec, end-use	11
% dw central heat	49	Heat/dw/DD,(MJ)	20.0
		Appl elec/DI,(kWh/DM)	0.043

RESIDENTIAL ENERGY USE - GERMANY

Year: 1965 Population: 59.0×10^6 Occ. Dw: 18.1×10^6

SFD: 48% DI/cap,(DM_{70}): 5840 Climate Index: 1.034

	Heat	Hot Water	Cooking	Appliances	Total
Oil,(PJ)	444	9.3	-	-	453
-Stock,(10^3)	4941	1032/250	-	-	-
-Unit Cons,(GJ)	89.8	7.9/4.3	-	-	-
Gas,(PJ)	35.3	17.0	17.6	-	69.9
-Stock,(10^3)	579	72/2625	7059(6335)	-	-
-Unit Cons,(GJ)	61.0	7.7/6.3	2.5	-	-
Solids,(PJ)	606	35.9	32.8	-	674
-Stock,(10^3)	12091	796/4300	9593(1810)	-	-
-Unit Cons,(GJ)	50.1	8.8/5.5	3.4	-	-
Elec,(PJ)	1.5/6.6	26.3	15.5	35.8	85.6
-Stock,(10^3)	181/4520	4706	9231	18100	-
-Unit Cons,(GJ)	[8.3]	5.7	1.7	2.0	-
Dist Ht,(PJ)	19.2	0.6	-	-	19.8
-Stock,(10^3)	308	127	-	-	-
-Unit Cons,(GJ)	62.4	5.1	-	-	-
TOTAL,(PJ)	1112	89.1	65.9	35.8	1303
	(85%)	(7%)	(5%)	(3%)	(100%)

STRUCTURAL INDICATORS:		ENERGY USE INDICATORSe:	
% dw oil heat	27	GJ/dw, end-use	72.0
% dw gas heat	3	GJ/dw, primary	81.1
% dw elec heat	1	% oil, end-use	35
% dw dist heat	2	% elec, end-use	7
% dw central heat	27	Heat/dw/DD,(MJ)	17.2
		Appl elec/DI,(kWh/DM)	0.029

NOTES

Structure

Dwellings and Central heating fraction: Suding; based on Energiewirtschaftliches Institut, Schmitt and Schiffer, Esso AG, and Deutsche BP AG.

Heat

Total consumption: See notes for 1972 table, except for oil, solids, and district heat; Suding. Reliable data for the 1960s are scarce, and estimates vary widely. Suding derived oil and solids consumption by developing unit consumption numbers from 1970s consumption and structural data (as well as assumptions about the relative energy use of different heating systems); these numbers, differentiated by dwelling and heating system type, were matched with appropriate stock numbers to yield a hypothetical consumption; this value was then corrected to yield a good match with actual consumption of the combined residential/commercial sector; for district heat, due to its relative unimportance in the 1960s, a plausible series was simply extapolated from 1970s data. The numbers for oil heating represent a compromise with other estimates.

Stock: See note for Dwellings.

Unit consumption: derived from total consumption and stock. The low number for electric heat is suspect.
Heat/dw/DD, end-use = 17.0 MJ

Hot Water

See notes for 1978 table.

Cooking

See notes for 1972 table, except: Stock; Suding, based on EWI.

Electric Appliances

See notes for 1972 table.

RESIDENTIAL ENERGY USE- GERMANY

Year: 1960 Population: 55.4×10^6 Occ. Dw: 15.4×10^6

SFD: 48% DI/cap,(DM_{70}): 4706 Climate Index: 0.947

	Heat	Hot Water	Cooking	Appliances	Total
Oil,(PJ)	157	2.6	-	-	160
-Stock,(10^3)	2094	354/~0	-	-	-
-Unit Cons,(GJ)	74.9	7.3/-	-	-	-
Gas,(PJ)	16.3	11.6	17.7	-	45.6
-Stock,(10^3)	185	15/1925	6622(6006)	-	-
-Unit Cons,(GJ)	88.3	7.8/6.0	2.7	-	-
Solids,(PJ)	621	33.2	38.8	-	693
-Stock,(10^3)	13044	462/4650	10472(2618)	-	-
-Unit Cons,(GJ)	47.6	8.4/4.6	3.7	-	-
Elec,(PJ)	0/3.3	10.5	12.4	20.7	46.9
-Stock,(10^3)	0/3080	1694	6160	15400	-
-Unit Cons,(GJ)	-	5.5	2.0	1.3	-
Dist Ht,(PJ)	6.0	<1	-	-	6.0
-Stock,(10^3)	77	31	-	-	-
-Unit Cons,(GJ)	78.4	4.7	-	-	-
TOTAL,(PJ)	803	57.9	68.9	20.7	951
	(84%)	(6%)	(7%)	(2%)	(100%)

STRUCTURAL INDICATORS:		ENERGY USE INDICATORS:	
% dw oil heat	14	GJ/dw, end-use	61.7
% dw gas heat	1	GJ/dw, primary	67.6
% dw dist heat	<1	% oil, end-use	17
% dw elec heat	~0	% elec, end-use	5
% dw central heat	16	Heat/dw/DD,(MJ)	14.5
		Appl elec/DI,(kWh/DM)	0.022

NOTES

See 1965 table, except:

Heat

Heat/dw/DD, end-use = 14.4 MJ

Hot Water

Stock: Suding; for central units, based on conversations with market research experts; for oil- and solids-burning bathroom units, based on Noelle and Neumann (1977), for gas bathroom and kitchen units, values interpolated.

It should be noted that there is substantial disagreement in the literature regarding the consumption of oil and solids for 1960.

SUMMARY

RESIDENTIAL ENERGY USE IN GERMANY 1960-1978

YEAR	1960	65	72	75	78
		STRUCTURE			
Occ. dw,(10^6)	15.4	18.1	21.4	22.6	23.9
SFD,(%)	48	48	48	48+	49
Cen Ht,(%)	16	27	49	57	66
Cen Ht-SFD,(%)	8	12	23	28	31('77)
Avg size,(sq.m.)	68.0	69.4	74.5	75.1	[76]
Pers/dw	3.44	3.17	2.80	2.62	[2.5]
Hot water,sat.(%)	[64]	[72]	84	[89]	94
DI/cap,(DM_{70})	4706	5840	7686	8012	8982
		ENERGY TOTALS			
End-use (PJ)	951	1303	1792	1875	2070
-fuel (PJ)	904	1217	1593	1628	1781
-elec (PJ)	47	86	199	247	289
-energy/dw (GJ)	62	72	84	83	87
Primary -energy/dw (GJ)	68	81	102	104	110
		HEAT			
Fuel,(PJ)	794	1085	1395	1401	1537
-sat.,(%)	99+	97	90	87	86
-oil/dw,(GJ)	74.9	89.8	95.1	87.8	88.0
-gas/dw,(GJ)	88.3	61.0	58.2	58.7	64.4
-solids/dw	47.6	50.1	40.9	37.8	41.0
Elec,(PJ)	3.3	8.0	46.7	61.9	76.7
-sat.,(%)	0/20	1/25	4/34	6/34	7/33
-elec/dw,(GJ)	-	[8]	38.2	38.4	36.9
Dist Ht,(PJ)	6.0	19.2	50.1	54.5	57.8
-sat,(%)	<1	2	5	7	8
-dist ht/dw,(GJ)	78.4	62.4	43.3	36.5	31.0
Total,(PJ)	803	1112	1492	1517	1672
Indicators:					
-heat/dw,(GJ)	52.5	62.2	72.2	69.9	73.0
-heat/dw/DD,(MJ)	14.5	17.2	20.0	19.3	20.2
-heat/dw/DD/m^2,(KJ)	213	248	268	257	266

RESIDENTIAL ENERGY USE IN GERMANY 1960-1978 (continued)

YEAR	1960	65	72	75	78
		HOT WATER			
Fuel,(PJ)	47.4	62.2	106	134	152
-sat.(%)	5/-	11/-	24/-	33/-	41/-
-fuel/dw,(GJ)	7.9/5.0	8.3/5.8	9.4/7.3	9.8/7.8	10.3/8.3
Elec,(PJ)	10.5	26.3	57.8	68.4	78.0
-sat,(%)	11	26	46	46	44
-elec/dw,(GJ)	5.5	5.7	6.5	6.9	7.2
Dist Ht,(PJ)	<1	0.6	3.8	6.1	8.8
-sat.,(%)	<1	<1	3	4	5
-dist ht/dw,(GJ)	4.7	5.1	6.4	6.7	7.2
Total,(PJ)	57.9	89.1	167	208	239
Indicators:					
-HW/dw,(GJ)	6.5	7.9	11.1	12.3	12.7
-HW/cap,(GJ)	1.9	2.5	4.0	4.7	5.1
-HW/cap(tot),(GJ)	1.1	1.7	3.2	4.0	4.7
		COOKING			
Fuel,(PJ)	56.5	50.4	38.2	33.1	25.1
-sat.,(%)	111(56)	92(45)	62(35)	50(32)	36(27)
-fuel/dw,(GJ)	3.3	3.0	2.9	2.9	2.9
Elec,(PJ)	12.4	15.5	21.0	25.0	29.4
-sat.,(%)	40	51	63	68	73
-elec/dw,(GJ)	2.0	1.7	1.6	1.6	1.7
Total,(PJ)	68.9	65.9	59.2	58.1	54.5
Indicator:					
-energy/dw,(GJ)	4.5	3.6	2.8	2.6	2.3
		APPLIANCES			
Elec,(PJ)	20.7	35.8	73.2	91.4	105
(TWh)	5.75	9.94	20.3	25.4	29.2
-elec/dw,(GJ)	1.4	2.0	3.4	4.0	4.4
- (kWh)	375	550	950	1125	1225
Indicators:					
-elec/cap,(kWh)	106	172	333	426	489
-elec/DI,(kWh/DM)	0.022	0.029	0.043	0.051	0.053

NOTES

Assembled from year tables.
Values given in brackets are extrapolated or estimated from data given in the literature.

Structure

Single-family dwellings (SFD) and centrally-heated SFD (CH-SFD): Suding; SFD includes one- and two-family houses.

Average size: Reents; estimated for 1978; although the average "Wohnflache" (living area) increased from 1970 to 1975, the trend from 1973 to 1975 is toward slightly smaller average size; the Statistisches Jahrbuch gives a value for "Wohnflaeche" for the first time in 1978 -- 80 m^2 -- but this number is so much higher than 1975 that it does not seem consistent with the time-series given by Reents; considering all of the above, we conservatively estimate a slight increase for 1978.

Persons per dwelling: Reents; estimated for 1978, assuming continuation of the downward trend of the 1970s. Note that (persons/dw) x (no. of dwellings) does not equal total population, since 3-4% of the population lives in institutions.

Heat

The indicator "Heat/dw/DD" uses the normal year (3613 DD; base 15 C/20 C) for all years, since the heating consumption numbers are already climate-adjusted. Total consumption for electric heat is the sum of storage heaters and portable heaters, but the unit consumption value refers only to storage heaters. The value for 1965 is suspect.

Hot Water

Saturation for fuel water heaters is given only for central water heating, since multiple ownership of different point-of-use water heaters obscures the question of saturation for those devices. For the total number of devices present in the housing stock, see the year tables. The saturation value given for electric water heaters refers to the number of dwellings with at least one electric water heater.
The unit consumption for fuel water heaters is a weighted average of oil, gas, and solids water heaters.
The number of dwellings with hot water facilities is given for 1972 and 1978 from the 1% housing survey. Other values are extrapolated linearly from those results; thus, some uncertainty exists, particularly for the 1960s. Saturation of water heating devices add up to well over 100% in the 1970s, but that does not mean that 100% of all dwellings have hot water facilities.

Cooking

Fuel/dw is a weighted average of the unit consumption of gas and solids cooking. Energy/dw assumes that all occupied dwellings have cooking facilities. This may be an overestimate (particularly in the 1960s), in which case energy/dw would be slightly higher. In the case of cooking, we make no adjustment when aggregating electricity with fossil fuel.

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ITALY

There has never been a systematic collection of Italian residential energy consumption data by end use. Until 1976, most attention was given to the supply side of the energy process, with almost no interest in energy demand. The destination of energy sources was disaggregated in few main sectors, with some detail only for industrial consumption. Residential energy use was always aggregated with the Commercial and Public sectors, and sometimes with Agriculture as well.

The WAES report, published in 1977, attempted for the first time a disaggregation of these two sectors. This report was based on 1972 data and presented some indicative estimates of principal figures for 1960, 1966, and 1969. While for electric consumption most of the information could be derived from the periodic surveys conducted by the national electric utility (ENEL), for the other principal end uses the research team from Montedison had to model the evolution of the consumption trends "from the bottom up".

The first analysis of Italian residential energy consumption by end-uses (based on 1975 data) was published by ENI in 1978. Since then, it has been slightly modified and corrected by the same board in collaboration with ENEL and Confindustria. Only recently -- February 1981 -- a new analysis of the energy end-uses has been presented by ENI for 1978, but this report distinguishes only between "electric" and "non-electric" sources. Other estimates have been elaborated for 1978 by Montedison, and were available in draft form directly from the authors.

More detailed information on 1977-78 is included in two recent studies sponsored by the National Council of Research (CNR). Two of them, on space heating and on hot water consumption, have appeared in the last few months. Both of these studies -- part of the "Progetto Finalizzato Energetica" -- are based on field surveys, and are mostly aimed at the analysis of the efficiency of the various systems used.

As can be seen from the bibliography, the information presented in the following tables has been gathered from both published and unpublished (mostly "personal communications") documents from governmental boards, energy agencies, research institutions, utilities, oil companies, industries, and academic research groups. Below is a list of the sources that also explains the abbreviations used:

ISTAT (Istituto Nazionale di Statistica), National Institute of Statistics;
MinInd (Ministero dell'Industria), Department of Industry;
ENI (Ente Nazionale Idrocarburi), National Board for Hydrocarbons;

ENEL (Ente Nazionale Energia Elettrica), National Electric Utility;
CNEN (Comitato Nazionale Energia Nucleare), National Committee for Nuclear Energy;
CNR (Consiglio Nazionale delle Ricerche), National Research Council [most of the energy research of CNR is undertaken under the Progetto Finalizzato Energetica (PFE); the subproject RERE (Riscaldamento negli Edifici Residenziali -- Heating in Residential Buildings) is the research arena for most of the specific studies we refer to];
IFA (Istituto di Fisica dell'Atmosfera), Institute of Atmospheric Physics;
Montedison, a chemical corporation that was responsible for the Italian WAES report (Workshop on Alternative Energy Strategies);
Confindustria, Confederation of the Private Industry;
AGIP, National Distribution Company for Energy Fuels (part of ENI group);
SNAM, National Company for Energy Sources Research & Development (part of ENI group);
Italgas, gas company with government participation;
GES (Gruppo Energia Solare), Solar Energy Group, University of Naples;
ITAC (Istitituto di Tecnologia dell'Ambiente Costruito), Institute of Technology of the Built Environment, Polytechnic Institute of Turin;
IFT (Istituto di Fisica Tecnica), Technical Physics Institute, University of Palermo.

Other sources are reported in the bibliography.

Some methodological considerations are specific to the Italian data-base:

* According to the general methodology adopted. only the occupied dwellings and their share of devices are considered in these tables. However, the energy totals include also the consumption of unoccupied and vacation homes (~ 2 million in 1978). Since the energy demand of this type of dwelling is around 10-20% of a normal dwelling, the redistribution of their consumption on the stock of the occupied dwellings can lead to a 1-2% overestimate of the specific consumption figures.

* The data presented in the tables are not adjusted for climate, while the indicators in the summary table account for it. The climate index presented is based on a normal of 2140 degree-days.

* The accounting of Liquid Petroleum Gas has presented some problems because of the lack of reliable information. Thus, we accounted it with oil in 1972 and 1978 (when the fuel split is based on Montedison data, disaggregated according to the original sources -- namely oil or natural

gas), and with gas in 1975 (when we use the information from ENI, disaggregated according to the fuel form -- namely liquid or gaseous).

• There is no district heating in Italy. The first system, in Brescia, started production in 1979.

RESIDENTIAL ENERGY USE - ITALY

Year: 1978 Population: 57.1×10^6 Occupied Dw: 16.8×10^6

SFD: 11% DI/cap, $10^3 L_{70}$: 850 Climate Index: 100.5

	Heat	Hot Water	Cooking	Appliances	Total
Oil, PJ	588	28.2	47.0	-	663
-Stock, 10^3	8820	2170	8410	-	-
-Unit Cons, GJ	66.6	13.0	5.6	-	-
Gas, PJ	179	27.2	27.6	-	234
-Stock, 10^3	3140	2170	4890	-	-
-Unit Cons, GJ	57.0	12.6	5.6	-	-
Coal, Coke, Wood, PJ	24.2	16.6	1.7	-	42
-Stock, 10^3	3960	1860	620	-	-
-Unit Cons, GJ	6.1	9.0	2.7	-	-
Elec, PJ	3.2	31.9	0.7	88.0	124
-Stock, 10^3	1580	7430	2700	16800	-
-Unit Cons, GJ	2.0	3.3	3.0	5.2	-
TOTAL, PJ	794	104	77	88	1063
	(75%)	(10%)	(7%)	(8%)	(100%)

STRUCTURAL INDICATORS:		ENERGY USE INDICATORS:	
% dw oil heat	52.5	GJ/dw, end-use	63
% dw elec heat	9	GJ/dw, primary	77
% dw central heat	57	% oil, end-use	62
		% elec, end-use	12
		Heat/dw/DD, MJ	22.4
		Appl elec/DI. kWh/10^3L	0.50

NOTES

The figures in this table are derived from three principal sources:
- the latest edition of the Indagine sulla Utenza Domestica, ENEL, 1980 (6), a complete survey of the saturation of the domestic energy consuming devices;
- a recent pubblication on end-uses by ENI (31), disaggregating by end-uses the "Electric" and "Non-Electric" energy consumption of the residential sector;
- a paper by Oliviero Bernardini from Montedison (16), with personal communications from the author adding details on the space heating end-use.
Additional information was found in the two CNR studies concerning Space Heat (11) and Hot Water (13).

Central heating estimate is based on the 1977 CNR-RERE survey. (There is considerable disagreement among the sources regarding this value: ENEL gives 48%, Montedison estimates 73%, while ENI simply report the 1977 value from CNR, 55.5%).
The climate index is derived from an ENI indication (30).

LPG is included in oil, since the sources that disaggregate the fuel consumption present kerosene and LPG together.

The disaggregation of the Heating energy figures by the different fuels was possible using the Bernardini notes. The stocks figures are from ENEL and include all systems, adding to a total higher than the number of dwellings. The Unit Consumption is then to be considered "per system". However, since we can estimate from the CNR-RERE report that 98% of the dwellings had some kind of space heating, we have calculated the heat indicators by dividing the energy consumption by this share of the occupied dwellings.
The stock of electric heating refers to the number of dwellings that use these systems. Electric central heating is negligeble.

Hot Water figures are estimates based on the Italgas analyses (13) and the ENEL survey. The stock figures refer to the number of dwellings. The ENEL survey asked for the ownership of "at least one" device of each type of fuel. So the result lead to a lower stock than the real number of operating systems, although higher than the number of dwellings with hot water (since a dwelling with one gas and one electric heater is counted twice, while a dwelling with two electric heaters is counted only once). The survey double-counts one million heaters, which we have considered equally distributed between the 81% of dwellings with hot water, in order to have a saturation level in terms of dwellings.
Electric hot water includes 7.2 PJ of thermal uses in washing machines and dish-washers that could have been supplied with other fuels. For the estimate of unit consumption we exclude this quantity from the 31.9 PJ of Electric Hot Water and divide by the number of dwellings (7.43

million).
Other HW energy figures have been estimated according to Italgas.

The Cooking stocks, derived from the ENEL survey, have been adjusted counting the "mixed fuels" devices (electricity + gas or + LPG) half in electricity and half in the other source. The double counting is avoided by normalizing the total stock from the ENEL split (106.5% of the dw) to the 98.9% of the dwellings that according to ENEL have some kind of cooking device (assuming then that the double counting is equally distributed between the various sources' shares).
Electric cooking devices refer to "only electric devices" for consistency with other countries.
Other cooking energy figures have been derived by difference and consistency with previous years.

Appliance energy use includes all uses for which the electric source is considered necessary ("usi elettrici obbligati"), and excludes the amount of hot water produced by washing machines and clothes washers. The end-use studies from ENI (1,2,31) give some estimates of the the annual energy use for hot water production of clothes-washing machines (1.5 GJ/unit), and of dishwashers (3.5 GJ/unit); these figures are derived from analyses of the devices on the market.

RESIDENTIAL ENERGY USE - ITALY

Year: 1975 Population: 56.0×10^6 Occupied Dw: 16.15×10^6

SFD: 12% DI/cap, $10^3 L_{70}$: 822 Climate Index: 100

	Heat	Hot Water	Cooking	Appliances	Total
Oil, PJ	585	34	-	-	619
-Stock, 10^3	NA	NA	-	-	-
-Unit Cons, GJ	NA	NA	-	-	-
Gas, PJ	149	36	73	-	258
-Stock, 10^3	NA	NA	13200	-	-
-Unit Cons, GJ	NA	NA	5.5	-	-
Solids, PJ	27	-	1	-	28
-Stock, 10^3	NA	-	200	-	-
-Unit Cons, GJ	NA	-	5.5	-	-
Elec, PJ	4	30	1	65	100
-Stock, 10^3	1020	6700	2240	16150	-
-Unit Cons, GJ	3.9	3.7	3.2	4.0	-
TOTAL, PJ	765	100	75	65	1005
	(76%)	(10%)	(7%)	(6%)	(100%)

STRUCTURAL INDICATORS:		ENERGY USE INDICATORS:	
% dw oil heat	NA	GJ/dw, end-use	62
% dw elec heat	6	GJ/dw, primary	74
% dw central heat	50	% oil, end-use	62
		% elec, end-use	10
		Heat/dw/DD, MJ	22.8
		Appl elec/DI, kWh/10^3L	0.39

NOTES

The figures presented in this table are based on a recent re-working of the ENI "Usi Finali" (1) attempted in a joint effort by ENI, Enel, and Confindustria (10). In January 1980 some further corrections of this report were directly communicated from the ENI authors (30). This source gives a disaggregation by end-use of the principal energy types. Since these are analyzed with regard to their physical form, gas includes LPG. The correction of this inconsistency with the other Italian tables, where LPG is included in oil, has not yet been possible because of missing information from SNAM and Italgas.
Central heating saturation has been estimated as for 1978: other values given in the literature are 58% (ENI) and 43% (CRESME).

Figures different from those given here were available for space heating from a recent article (18); although they seem more consistent in terms of unit consumption, they are much too high in their totals if applied to the stock of dwellings having some kind of heating system (97% according to ENI). This source gives 69.3 GJ/dw for fuel-heated dwellings, and 13.7 GJ/dw for electric-heated dwellings. We have then interpreted these figures as refering to the centrally-heated dwellings ("centralizzati" and "autonomi"). The figures in the table also include all dwellings heated by stoves (39%), and thus lead to much lower figures -- 52 GJ/dw -- for fuel and only 3.9 GJ/dw for electric-heated dwellings. The stock figure for electric heat -- from ENEL -- seems consistent with the 1977 survey from CNR-RERE.

The indicator heat/dw-dd refers to the number of heated dwellings (97%).

Hot Water consumption is the highest of various estimates available. The electric figure includes ~5 PJ of thermal uses in washing machines and dish washers that could have been supplied with other fuels at a temperature of 40C.
The stock of electric water heaters is from Enel (6), confirmed by the Italgas survey. From ENI-ENEL we know that there are 13.4 million heaters in 12.1 million dwellings: 6 million fuel, and 7.4 million electric. The figures in the table account for an average of 1.1 heater/dw in 75% of the occupied dwellings (12.1×10^6). The unit consumption for electricity refers only to hot water heaters (25 PJ divided by the 6.7 million dwellings with electric hot water heaters). We have excluded the hot water from washing machines from this computation. We can calculate HW/dw, including the washers' energy consumption in the 12.1×10^6 dwellings with hot water (supposing that washers are only in the dwellings that have hot water heaters): this figure is 8.3 GJ/dw, and is in the summary table.

The electric cooking stock is derived from the Enel survey (6). It accounts here for the "electric-only" kitchens (210,000 units, to which the unit consumption refers), and for half of the "mixed" kitchens (electricity + gas). The other half is counted with gas. Electric unit consumption refers to "electric only" devices (from ENEL). Since ~97% of all dwellings have some kind of cooking device, 13.4 million use fuels with an average unit consumption of 5.5 GJ/dw.

Appliance energy use has been calculated as for 1978.

RESIDENTIAL ENERGY USE - ITALY

Year: 1972 Population: 54.6×10^6 Occupied Dw: 15.5×10^6

SFD: 12% DI/cap, $10^3 L_{70}$: 817 Climate Index: 98.7

	Heat	Hot Water	Cooking	Appliances	Total
Oil,PJ	639	3	3	-	645
-Stock,10^3	NA	NA	NA	-	-
-Unit Cons,GJ	NA	NA	-	-	-
Gas,PJ	62.3	24.0	44.2	-	130
-Stock,10^3	2600	2000	10500	-	-
-Unit Cons,GJ	23.7	12.6	4.2	-	-
Solids,PJ	46.4	2	7	-	55
-Stock,10^3	NA	NA	NA	-	-
-Unit Cons,GJ	NA	NA	-	-	-
Elec,PJ	4.9	24.4	1.0	59.1	90
-Stock,10^3	900	6120	1770	15480	-
-Unit Cons,GJ	5.5	3.2	2.9	3.8	-
TOTAL,PJ	753	53	55	59	920
	(82%)	(6%)	(6%)	(6%)	(100%)

STRUCTURAL INDICATORS:		ENERGY USE INDICATORS:	
% dw oil heat	NA	GJ/dw,end-use	59
% dw elec heat	6	GJ/dw,primary	70
% dw central heat	41	% oil, end-use	70
		% elec, end-use	10
		Heat/dw/DD,MJ	24.3
		Appl elec/DI,kWh/10^3L	0.37

NOTES

We have derived energy use values for 1972 using several data sources: the WAES report (15), the Conti-ISPRA presentation to the EEC (26), the Enel survey (6), and the CRESME report (14).

Totals by energy type were taken from WAES (LPG is included in oil). Totals by end-use given by WAES were slightly modified based on information in the other sources in order to maintain a closed balance.
Oil has been estimated by Conti (27). Hot water and cooking were derived by subtracting the appropriate fraction of residential consumption given by WAES from the Conti evaluation for Residential+Commercial.
Gas end-use disaggregation has been estimated using the WAES estimates of the gas share in different uses, as well as estimates of unit consumption by Bernardini at Montedison (17). We made slight adjustments in order to make the sum correspond to the total from WAES -- which we have adopted as a basic assumption -- and the heat consumption figure from Conti.
The disaggregation of solids has been estimated with the same method used for oil. We also had some figures from GES (24) for the "Fuel" share of hot water energy use, to which we have subtracted gas before splitting the rest between oil and solids.
Electric end-uses have been estimated on the basis of the WAES report, which gives a complete disaggregation, as well as more precise estimates from Bernardini and some figures from ENEL. Hot water electric consumption includes 4.8 PJ used for clothes and dish-washers; the stock and the unit consumption refer to the dwellings having hot water heaters (~55% of the dwellings). We have estimated by comparison of our sources an average of 1.05 heaters/dw.
Heat/dw/DD refers to the heated fraction (95%) of the total occupied dwellings.

RESIDENTIAL ENERGY USE - ITALY

Year: 1960 Population: 50.2×10^6 Occupied Dw: 12.8×10^6

SFD: 11% DI/cap, $10^3 L_{70}$: 490(61) Climate Index: 102.9

	Heat	Hot Water	Cooking	Appliances	Total
Oil,PJ	NA	NA	NA	-	NA
-Stock,10^3	NA	NA	NA	-	-
-Unit Cons,GJ	NA	NA	NA	-	-
Gas,PJ	NA	NA	NA	-	NA
-Stock,10^3	NA	NA	NA	-	-
-Unit Cons,GJ	NA	NA	NA	-	-
Solids,PJ	NA	NA	NA	-	NA
-Stock.10^3	NA	NA	NA	-	-
-Unit Cons,GJ	NA	NA	NA	-	-
Elec,PJ	4.1	3.2	1.0	11.7	20
-Stock,10^3	500	1100	770	12800	-
-Unit Cons,GJ	8.2	2.9	3.4	0.9	-
TOTAL,PJ	205	43.4	43.1	10.1	302
	(68%)	(14%)	(14%)	(3%)	(100)%

STRUCTURAL INDICATORS:		ENERGY USE INDICATORS:	
% dw oil heat	NA	GJ/dw,end-use	24
% dw elec heat	4	GJ/dw.primary	27
% dw central heat	~10	% oil, end-use	NA
		% elec, end-use	7
		Heat/dw/DD,MJ	9.8
		Appl elec/DI,kWh/10^3L	0.11

NOTES

Data on Italian residential energy consumption in the 1960s is almost nonexistent. Before the WAES report (based on 1972 energy consumption) the only disaggregation included commercial with residential. Our rough estimates are based on scattered figures estimated by WAES and by Enel.

According to the ISTAT census in 1961, some kind of heating system is present in ~75% of the occupied dwellings. This means 9.6 million dwellings, of which we estimated 9.1 fuel -heated and 0.5 million electric-heated. The figure for total heat and for electric heat are from WAES. According to this source, 2% of space heat is supplied by electricity (4.1 PJ). Unit consumption figures are then derived for electric heat and fuel heat (see summary table).

Hot water totals have been constructed using the average hot water energy use from GES (23), and figures of total consumption/dw from WAES. Unit consumption of electric hot water heaters is from WAES. We have derived the stock of heaters from ENEL series 62-78 (6), and assumed that hot water for washing machines is negligeble (the saturation was in fact 0.04% for dish-washers and 7.8% for clothes-washers [Bernardini pers. comm., 17]). Total electric consumption is then derived assuming that heater/dw = 1.

Cooking figures are from WAES and ENEL. Unit consumption refer to 150,000 "electric only" devices.

Electric Appliances are given by the sum of consumption (ENEL(6), Bernardini(17)) of the major appliances, adjusted with the total electricity figure to include the smaller appliances. The total may be slightly underestimated because of the exclusion of some small appliances.

SUMMARY

RESIDENTIAL ENERGY USE IN ITALY 1960-1978

YEAR	1960	72	75	78
		STRUCTURE		
Occ. Dw, 10^6	12.79	15.50	16.15	16.80
SFD,%	22	22	25	29
Cen Ht,%	~10	41	50	57
Cen Ht-SFD,%	NA	NA	9	17
Hot water sat.,%	NA	55	75	81
Avg Size,sq.m.	58	65	69	73
Pers/dw	3.91	3.51	3.47	3.40
Area/cap,sq.m.	14.8	18.5	19.9	21.5
DI/cap, $10^3 L_{70}$	490	817	822	850
Climate Index	102.9	98.7	100.0	100.5
		ENERGY TOTALS		
End-use,PJ	302	920	1005	1063
-fuel,PJ	288	830	905	939
-elec,PJ	20	90	100	124
-energy/dw,GJ	24	59	62	63
Primary -energy/dw,GJ	27	70	74	77
		HEAT		
Fuel,PJ	201	748	761	791
-sat.,%	71	79	91	95
-fuel/dw,GJ	22	61	52	50
Elec,PJ	4.1	4.9	4.1	3.2
-sat.,%	3.9	5.8	6.3	9.4
-elec/dw,GJ	8.2	5.5	3.9	2.0
Total,PJ	205	753	765	794
Indicators:				
-heat/dw,GJ	21.0	51.9	48.8	47.9
-heat/dw/DD,MJ	9.8	24.3	22.8	22.4
-heat/dw/DD/m^2,KJ	167	374	326	306

RESIDENTIAL ENERGY USE IN ITALY 1960-1978 (continued)

YEAR	1960	72	75	78
		HOT WATER		
Fuel,PJ	40	29	70	72
-sat.,%	NA	20.2	33.4	36.8
-fuel/dw,GJ	NA	9.2	13.0	11.6
Elec,PJ	3.2	24.4	30	32
-sat.,%	8.6	39.5	41.5	44.2
-elec/dw,GJ	2.9	3.2	3.7	3.3
Total,PJ	43	53	100	104
Indicators:				
-HW/dw,GJ	NA	8.3	9.5	8.8
-HW/cap,GJ	NA	1.8	2.4	2.2
-HW/cap(total),GJ	0.9	1.2	1.8	2.1
		COOKING		
Fuel,PJ	42	54	74	76
-sat.,%	93.8	88.4	86.1	83.8
-fuel/dw,GJ	3.5	3.9	5.3	5.5
Elec,PJ	1.0	1.0	1.0	0.7
-sat.,%	6.0	11.4	13.9	16.2
-elec/dw,GJ	3.4	2.9	3.2	3.0
Indicator:				
energy/dw,GJ	3.36	3.55	4.64	4.56
		APPLIANCES		
Elec,PJ	11.7	59.1	65.0	88.0
-TWh	3.3	16.4	18.1	24.4
-elec/dw,GJ	0.91	3.8	4.0	5.2
-kWh	255	1060	1120	1455
Indicators:				
-elec/cap,kWh	65	301	322	428
-elec/DI,kWh/$10^3 L_{70}$	0.13	0.30	0.39	0.50

NOTES

These data are assembled from the detailed year tables.

The average size of dwellings has been estimated on the basis of Istat and ENI data. A much higher figure (99 sq.m.) is presented in the CNR-RERE report for 1977, but it seems to be including all common spaces in the building.

The Space Heating indicators account for climate variation among the years.

Hot Water saturation and unit consumption refers to the heaters, as explained in the year tables. The HW/dw indicator includes the consumption for washing machines (4 PJ in 72, 5 PJ in 75, 7.2 PJ in 78). We assume that this consumption is equally distributed among the dwellings with hot water (9.3 million in 1973, 12.1 in 1975, 13.6 in 1978). HW/cap accounts only for the people living in the housing stock with hot water. For 1960 we do not know how many dwellings had hot water. HW/cap(total) is calculated for the total population.

Cooking fuel share is derived assuming that all dwellings have a cooking device, as is the Cooking/dw indicator. Electric cooking unit consumption refers to "electric only" devices (in not more than 1% of the dwellings), while the stock and the total consumption accounts also for half the stock of the "mixed fuel" devices.

Appliances energy use does not include hot water produced by washing machines.

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JAPAN

Various Japanese sources give a complete disaggregation of the principal residential end-uses by energy sources for the years 1965-77. However, no information is given on the stock of the energy-using devices. These disaggregations are in fact derived from family expenditure surveys, dividing the quantities delivered by the prices. It is therefore difficult if not impossible to derive any figures for unit consumption. In these sources, the number of families is taken from the National Income Division, which gives figures larger than the Census surveys.

The only source that attempts an evaluation of the stocks and of the unit consumption is the Japan Institute of Energy & Economics (IEE), who give detailed estimates of 1973 and 1979 energy end-uses. These are derived from surveyed saturation rates and unit consumption levels. This source is based on the number of Households as from the Census Office, which differs from the figures from the National Income Division.

We have thus for Japan two series of data based on fundamentally different approaches, the first being a disaggregation from a totally aggregated ensemble, while the second is a derivation from a highly disaggregated survey. Thus:
the IEE data for 1973 and 1979 are consistant between them but not with the series derived from family expenditures for 1965, 1968, 1975, and 1977.

Personal Disposable Income does not appear in the Japan Statistical Yearbooks. Thus, we use "Private Income" from the table of National Income per Capita as a surrogate statistic. This figure could be high by roughly 10%, due to the inclusion of personal taxes and non-tax payments.

In reading the tables, note the following:

- the Climate Index refers to a population-weighted average of degree-days given in the Climate Statistic Annual Report. This value -- based on 14° C -- has been transformed to base 18° C according to the calculations for 1970 from H. Nakagami published by the Science and Technology Agency (20). The values estimated for that year are 2130 DD base 18° C and 1345 DD base 14° C. Since 1970 is a peak year in the usual japanese climate, we have then indexed all the values at the level 1800 DD = 100, that is also the long range estimate given by IEE.

- There are in Japan 30 district-heating systems whose customers are

mostly from the commercial sector. We have here neglected the accounting of the small number of residential customers on which poor data is available.

* Electric cooling accounts for an important part of Japanese energy consumption. We include it in "Appliances" end use, and put its value in parentheses (A.C.).

* In the following tables LPG is included in Oil.

RESIDENTIAL ENERGY USE - JAPAN

Year: 1979 Population: 116.3×10^6 Occupied Dw: 33.2×10^6

SFD: 65% DI/cap, $10^3 Y_{70}$: 701 Climate Index: 85.7

	Heat	Hot Water	Cooking	Appliances	Total
Oil,PJ	287	211	82.3	-	580
-Stock,10^3	52935	30103	30799		
-Unit Cons,GJ	5.4	7.0	2.6		
Gas,PJ	22.8	161	63.5	-	247
-Stock,10^3	4475	24784	24419		
-Unit Cons,GJ	5.1	6.5	2.6		
Solids,PJ	18.3	5.4	2.8	-	26.5
-Stock,10^3	NA	NA	NA		
-Unit Cons,GJ					
Elec,PJ	23.0	44.6	14.1	247(17.5)	329
-Stock,10^3	66242	2391	29186	33204(15872)	
-Unit Cons,GJ	0.35	18.7	0.48	7.4(1.1)	
TOTAL,PJ	351	422	163	247	1183
	(30%)	(36%)	(14%)	(21%)	(100%)

STRUCTURAL INDICATORS:		ENERGY USE INDICATORS:	
% dw oil heat	NA	GJ/dw,end-use	35.6
% dw elec heat	NA	GJ/dw,primary	54.4
% dw central heat	4	% oil, end-use	49
		% elec, end-use	28
		Heat/dw/DD	7.1
		Appl elec/DI,kWh/10^3Y	0.84

NOTES

All data are from the most recent study by IEE, "National Living Standards and Residential/Commercial Energy Demand", October 1980.
The number of dwellings refers to the Households as from the Census Office.

The IEE report gives saturation rates and Unit Consumption for ten different types of space heating devices, six of hot water, six of cooking, and for eleven categories of electric appliances. The stock figures refer to the number of devices (except for "appliances", where the figure refer to Households), and thus lead to totals much higher than 100%. Unit Consumption is an average figure "per device"; the range of variation is great, from 24.3 GJ/y for central heating systems to 4.0 GJ/y of portable fuel heaters.
Electric heat is from "kotatsu" (0.52 GJ/y) and electric blankets (0.14 GJ/y).

For Solids, our source does not give the saturation and Unit Consumption figures.

RESIDENTIAL ENERGY USE - JAPAN

Year: 1977 Population: 113.5×10^6 Occupied Dw: 34.20×10^6

SFD: 67% DI/cap, $10^3 Y_{70}$: 688 Climate Index: 103.2

	Heat	Hot Water	Cooking	Appliances	Total
Oil, PJ	266	190	51.7	-	507
-Stock, 10^3	NA	NA	NA		
-Unit Cons, GJ					
Gas, PJ	25.8	160.1	71.5	-	257
-Stock, 10^3	NA	NA	NA		
-Unit Cons, GJ					
Solids, PJ	13.6	5.7	6.0	-	25.3
-Stock, 10^3	NA	NA	NA		
-Unit Cons, GJ					
Elec, PJ	22.3	39.3	40.0	186(12.2)	287
-Stock, 10^3	NA	NA	NA	34200	
-Unit Cons, GJ				5.4	
TOTAL, PJ	327	395	169	186	1077
	(30%)	(37%)	(16%)	(17%)	(100%)

STRUCTURAL INDICATORS:		ENERGY USE INDICATORS:	
% dw oil heat	NA	GJ/dw, end-use	31.5
% dw elec heat	NA	GJ/dw, primary	47.4
% dw central heat	3	% oil, end-use	47
		% elec, end-use	27
		Heat/dw/DD, MJ	5.3
		Appl elec/DI, kWh/10^3Y	0.66

NOTES

All data are from "Japanese Residential Energy Conservation", a draft report obtained from Murikami. The figures presented in that report are based on number of households from National Income Division.

Central heating figure is from the Economic Planning Agency (21).

Cooking is extrapolated from "other uses", except for electricity, which is -- in the JREC report -- presented in aggregate form for both cooking and appliances (cooling being excluded). We have estimated the share of electric cooking using the 1973 data from IEE as reference for the split between electric cooking and electric appliances (cooling excluded).

Heat/dw/DD has been estimated using the total number of households.

RESIDENTIAL ENERGY USE - JAPAN

Year: 1975 Population: 111.9×10^6 Occupied Dw: 33.04×10^6

SFD: 65% DI/cap, $10^3 Y_{70}$: 676 Climate Index: 107.1

	Heat	Hot Water	Cooking	Appliances	Total
Oil,PJ	238	170	45.9	-	454
-Stock,10^3	NA	NA	NA		
-Unit Cons,GJ					
Gas,PJ	24.6	147	68.8	-	240
-Stock,10^3	NA	NA	NA		
-Unit Cons,GJ					
Solids,PJ	23.4	10.4	8.3	-	42
-Stock,10^3	NA	NA	NA		
-Unit Cons,GJ					
Elec,PJ	19.8	29.0	37.2	172(11.8)	258
-Stock,10^3	NA	NA	NA	33040	
-Unit Cons,GJ	NA	NA	NA	5.2	
TOTAL,PJ	306	356	160	172	994
	(30%)	(36%)	(16%)	(17%)	(100%)

STRUCTURAL INDICATORS:		ENERGY USE INDICATORS:	
% dw oil heat	NA	GJ/dw,end-use	30.1
% dw elec heat	NA	GJ/dw,primary	44.8
% dw central heat	NA	% oil, end-use	46
		% elec, end-use	26
		Heat/dw-DD,MJ	5.0
		Appl elec/DI, kWh/10^3Y	0.63

NOTES: see 1977 table.

RESIDENTIAL ENERGY USE - JAPAN

Year: 1973 Population: 109.1×10^6 Occupied Dw: 29.4×10^6

SFd:65% DI/cap, $10^3 Y_{70}$: 676

	Heat	Hot Water	Cooking	Appliances	Total
Oil,PJ	334	163	68.5	-	565
-Stock,10^3	43600	24530	24560		
-Unit Cons,GJ	7.6	6.7	2.5		
Gas,PJ	14.0	100	46.9	-	161
-Stock,10^3	3180	17020	18770		
-Unit Cons,GJ	4.4	5.9	2.5		
Solids,PJ	30.4	17.4	5.0	-	53
-Stock,10^3	4000	1764	-		
-Unit Cons,GJ	7.6	9.9	-		
Elect,PJ	26.4	4.2	24.6	143(11.3)	198
-Stock,10^3	50575	294	41094	29406(4382)	
-Unit Cons,GJ	0.5	16.1	0.6	4.8(2.6)	
TOTAL,PJ	404	285	145	143	977
	(41%)	(29%)	(15%)	(15%)	(100%)

STRUCTURAL INDICATORS:		ENERGY USE INDICATORS:	
% dw oil heat	NA	GJ/dw,end-use	33.2
% dw elec heat	NA	GJ/dw,primary	46.0
% dw central heat	2	% oil, end-use	58
		% elec, end-use	20
		Heat/dw-DD,MJ	7.6
		Appl elec/DI, kWh/10^3Y	0.54

NOTES

Principal source of this table is the report "Analysis of the Structure of Residential Energy Consumption - Analysis of the Present Structure and Prediction of Demand for 1985 -", issued in 1975 by the Japan Institute of Energy & Economics. This report makes detailed estimates of 1973 residential energy end use and projects from them the future energy consumption patterns. Other sources provide slightly different energy figures.

Heat consumption is estimated for all heating devices. The stock refers to all systems, either central or room-heaters. Most of the dwellings have more than one system. For oil, solids and gas these are all counted as stoves, while for electricity the source consider the stoves (4.7 millions), the "kotatsu"--small heaters placed under the table--(37.8 millions), and "others", for which the stock is not known. We have assumed that these "other" systems are consistant with the average between stoves and kotatsu, although these have considerably different unit consumption (stoves: 1.7GJ/y, kotatsu: 0.4GJ/y).

The stock of Hot Water systems needs some description: Electric water heaters are only large devices with storage, working during off-peak hours. Gas-burning systems include water heaters and bath-tub heaters. The water heaters are either with storage or without, and use on the average 4.1 GJ/y. The bath-tub heaters have convection systems applied to the tub and have an average use of 7.9 GJ/y. Oil-burning systems, as well as thes using other solids, are all bath-tub heaters.

The numbers in parenthesis in the column of Appliances refer to energy for air conditioning. These figures are included in the totals. They are derived from observing the peak residential load growth.

Stock figures for Cooking were not available for oil- and solids-burning ranges. For gas and electricity the stock figures refer to the total number of cooking devices, most of them being "rice cookers" (14 millions using gas, 15 millions electric), then gas ranges (29 millions), electric warmers (18 millions), microwave ovens (3 millions), and 5 millions of "other" devices. The Unit Consumption figures are averages derived from these diverse stocks.

RESIDENTIAL ENERGY USE - JAPAN

Year: 1968 Population: 101.3×10^6 Occupied Dw: 27.11×10^6

SFD: 67% DI/cap, $10^3 Y_{70}$: 427 Climate Index: 100.2

	Heat	Hot Water	Cooking	Appliances	Total
Oil,PJ	96.4	58.5	24.2	-	179
-Stock,10^3	NA	NA	NA		
-Unit Cons,GJ					
Gas,PJ	23.5	62.4	42.0	-	128
-Stock,10^3	NA	NA	NA		
-Unit Cons,GJ					
Solids,PJ	130	47.9	29.2	-	207
-Stock,10^3	NA	NA	NA		
-Unit Cons,GJ					
Elec,PJ	9.2	1.9	15.1	82.1(2.7)	108
-Stock,10^3	NA	NA	NA	27110	
-Unit Cons,GJ	NA	NA	NA	3.0	
TOTAL,PJ	259	171	111	82	622
	(42%)	(28%)	(18%)	(13%)	(100%)

STRUCTURAL INDICATORS:		ENERGY USE INDICATORS:	
% dw oil heat	NA	GJ/dw,end-use	22.9
% dw elec heat	NA	GJ/dw,primary	30.5
% dw central heat	<1	% oil, end-use	29
		% elec, end-use	17
		Heat/dw-DD,MJ	5.3
		Appl elec/DI, kWh/10^3Y	0.53

NOTES: See 1977 table.

Central Heating refers to "hot air furnaces" only.

RESIDENTIAL ENERGY USE - JAPAN

Year: 1965 Population: 98.3×10^6 Occupied Dw*: 24.66×10^6

SFD: 72% DI/cap, $10^3 Y_{70}$: 294 Climate Index: 117.1

	Heat	Hot Water	Cooking	Appliances	Total
Oil,PJ	48.6	33.8	17.5	-	100
-Stock,10^3	NA	NA	NA		
-Unit Cons,GJ					
Gas,PJ	10.8	47.9	37.1	-	96
-Stock,10^3	NA	NA	NA		
-Unit Cons,GJ					
Solids,PJ	137	75.4	38.9	-	252
-Stock,10^3	NA	NA	NA		
-Unit Cons,GJ					
Elec,PJ	5.7	0.1	14.4	57.7(1.5)	78
-Stock,10^3	NA	NA	NA	24660	
-Unit Cons,GJ				2.3	
TOTAL,PJ	202	157	108	58	525
	(38%)	(30%)	(21%)	(11%)	(100%)

STRUCTURAL INDICATORS:		ENERGY USE INDICATORS:	
% dw oil heat	NA	GJ/dw,end-use	21.3
% dw elec heat	NA	GJ/dw,primary	27.3
% dw central heat	<1	% oil, end-use	19
		% elec, end-use	15
		Heat/dw/DD,MJ	3.9
		Appl elec/DI, kWh/10^3Y	0.55

NOTES: See 1968 table.

SUMMARY

RESIDENTIAL ENERGY USE IN JAPAN 1965-1979

YEAR	1965	68	73	75	77	79
			STRUCTURE			
Households, 10^6	24.66	27.4	29.4&	33.04	34.20	33.20&
SFD,%	72	67	65	65	67	65
Cen Ht,%	<1	<1	2&	NA	3	4&
Cen Ht-SFD,%	NA	NA	NA	NA	NA	NA
Avg Size,sq.m.	73.1	73.9	77.3	78.7	80.0	80.2
Pers/HH	4.1	3.8	3.5	3.4	3.3	3.2
Hot water sat.,%	NA	NA	NA	NA	NA	NA
DI/cap, $10^3 Y_{70}$	294	427	676	676	688	701
Climate Index	117.1	100.2	103.4	107.1	103.2	85.7
			ENERGY TOTALS			
End-use,PJ	525	622	977&	994	1077	1183&
-fuel,PJ	447	514	779&	736	790	854&
-elec,PJ	78	108	198&	258	287	329&
-energy/dw,GJ	21.3	22.9	33.2&	30.1	31.5	35.6&
Primary -energy/dw,GJ	27.3	30.5	46.0&	44.8	47.4	54.4&
			HEAT			
Fuel,PJ	197	249	378&	286	305	328&
-sat.,%	NA	NA	NA	NA	NA	NA
-fuel/dw,GJ	NA	NA	NA	NA	NA	NA
Elec,PJ	5.7	9.2	26.4&	19.8	22.3	23.0&
-sat.,%	NA	NA	NA	NA	NA	NA
-elec/dw,GJ	NA	NA	NA	NA	NA	NA
Total,PJ	202	259	404&	306	327	351&
Indicators:						
-heat/dw,GJ	7.1	9.6	13.7&	8.9	9.6	12.7&
-heat/dw/DD,MJ	3.9	5.3	7.6&	5.0	5.3	7.1&
-heat/dw/DD/m^2,KJ	54.0	72.2	98.6&	63.0	66.5	88.3&

RESIDENTIAL ENERGY USE IN JAPAN 1965-1979 (continued)

YEAR	1965	68	73	75	77	79
			HOT WATER			
Fuel,PJ	157	169	281&	327	356	377&
-sat.,%	NA	NA	NA	NA	NA	NA
-fuel/dw,GJ	NA	NA	NA	NA	NA	NA
Elec,PJ	0.1	1.9	4.2&	29.0	39.3	44.6&
-sat.,%	NA	NA	NA	NA	NA	NA
-elec/dw,GJ	NA	NA	NA	NA	NA	NA
Total,PJ	157	171	285&	356	395	422&
Indicators:						
-HW/dw,GJ	6.4	6.3	9.8&	11.2	12.1	13.4&
-HW/cap(tot),GJ	1.6	1.7	2.6&	3.3	3.7	3.8&
			COOKING			
Fuel,PJ	93.5	95.4	120&	123	129	149&
-sat.,%	NA	NA	NA	NA	NA	NA
-fuel/dw,GJ	NA	NA	NA	NA	NA	NA
Elec,PJ	14.4	15.1	24.6&	37.2	40.0	14.1&
-sat.,%	NA	NA	NA	NA	NA	NA
-elec/dw,GJ	NA	NA	NA	NA	NA	NA
Total,PJ	108	111	145&	160	169	163&
Indicator:						
-energy/dw,GJ	4.7	4.4	5.4&	5.4	5.5	5.1&
			APPLIANCES			
Elec,PJ	57.7	82.1	143&	172	186	247&
-TWH	16.0	22.8	39.6&	47.8	51.6	68.6&
-elec/dw,GJ	2.3	3.0	4.8&	5.2	5.4	7.4&
-KWh	640	840	1345&	1445	1510	2055&
Indicators:						
-elec/cap,KWh	163	225	363&	427	455	590&
-elec/DI,KWh/10^3Y_{70}	0.55	0.53	0.54&	0.63	0.66	0.84&

NOTES

These data are assembled from the detailed year tables.

The space heating indicators account for climate variations among years. Hot water indicators use the total number of households since we do not have the saturation of hot water facilities. Thus, HW/dw considered for dwellings with hot water would be higher then that given, especially for the 1960s.

The two years from IEE, 1973 and 1979, are marked with "&" and can be compared only between themselves. (See the introduction and the year tables for more details).

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Most of the Japanese sources have been analyzed in their original versions. The translation of some of the titles could be then incorrect.

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SWEDEN

In the following tables we present detailed breakdowns of energy use in the residential sector in Sweden for several years between 1963 and 1978. Each table is accompanied by a detailed explanation of how each quantity was obtained or derived. The following conventions have been adopted for the yearly tables:

-- Where accurately known, the split between SFD and MFD (central heating percentage, unit consumption, total consumption, number of units) is given with a slash separating the two. Totals are given for these aggregated; disaggregated totals can be derived from stocks and unit consumption.

-- We have separated hot water from heat, based upon information in Energi Beredskaps Utredningen (EBU) and estimates of the number of dwellings with running hot water. On the basis of several incomplete surveys and common practice in most Swedish studies (See especially EBU 1975), we have assumed that the principal heating source for a centrally heated dwelling is also the source for hot water. (oil, electricity, district heat, central gas, roughly half of the dwellings heated centrally with solids). This probably underestimates the ownership of electric hot water heaters in homes with central oil heat and in many homes without central heat. Hot water figures, therefore, should be viewed as very rough. Only 66% of all dwellings had running hot water at the time of the 1960 census, compared with nearly all dwellings in 1978. In all cases we follow the Swedish literature in assigning a shadow value for each energy and dwelling type, and assume the same use/dwelling for all years. This in effect says that the trends that lead to greater hot water use (more and/or bigger devices) balance decreased family size and conservation.

The official Swedish normal degree-day total, 3760 DD, is adjusted upward to 4010 DD (base 18° C) to be compatible with that of other countries. However, the yearly climate index given is that published in Sweden, which uses a base of 17° C.

Figures for 1978 reflect detailed surveys of the use of wood and electric supplementary heating. Such figures were not available for earlier years, hence time series of Swedish data should be approached cautiously.

Abbreviations used: CDL -- Centrala Drift Ledningen (Central Board of Management, the Association of Electric Utilities) FERA -- Foerening foer Rationella Electricitet Anvaending FF -- "Fastighets Foervalting" (property maintenance, electricity consumed in elevators, laundry rooms,

stairways, etc, of apartment buildings). FOB -- "Folk och Bostadsraekningen", the five-year National census. SCB -- Statistiska Central Byraan (Central Bureau of Statistics); SSPB -- Swedish State Power Board (Vattenfall) SOU67 -- Finans Departementet (Dept. of Finance) 1967 study. SIND -- State Board of Industry VVF -- Vaermeverksfoereningen (Association of District Heating Producers).

RESIDENTIAL ENERGY USE - SWEDEN

Year: 1978 Population: 8.284×10^6 Occ. Dw: 3.63×10^6

SFD: 43% DI/cap,(Skr_{70}): 13900(est) Climate Index: 1.09

	Heat	Hot Water	Cooking	Appliances	Total
Oil,PJ	162	50.0	-	-	212
-Stock,10^3	875/1185	875/1185			
-Unit Cons.,GJ	110/44.7	30/20			
Gas,Kero,PJ	2.35	0.30	0.75	-	3.4
-Stock,10^3	15/15	15/	280		
-Unit Cons.,GJ	80/40	20/	2.7		
Wood,PJ	9.3+11.3/0.2	0.1	0.3	-	21.2
-Stock,10^3	95/5	5/0	100		
-Unit Cons.,GJ	98/40	25/	2.5		
Coke,PJ	0.3	0.1	-	-	0.4
-Stock,10^3	5/	5/			
-Unit Cons.,GJ	80/	20/			
Elec,PJ	20.6+2	10.4	8.7	39.4	81.1
-Stock,10^3	443/55	543/55	3230	3630	
-Unit Cons.,GJ	43.5/24.5	18/12	2.7	10.9	
Dist Ht,PJ	37.3	15.4	-	-	52.7
-Stock,10^3	48/816	48/816			
-Unit Cons.,GJ	80/41	20/17.6	-	-	
TOTAL,PJ	245.4	76.2	9.8	39.4	371
	(66%)	(21%)	(3%)	(10%)	(100%)

STRUCTURAL INDICATORS:		ENERGY USE INDICATORS:	
% dw oil heat	57	GJ/dw,end-use	102
% dw elec heat	14	GJ/dw,primary	148
% dw dist heat	24	% oil, end-use	57
% dw central heat	~98	% elec, end-use	22
	(96/99)	Heat/dw/DD,MJ	19.1
		Appl elec/DI,kWh/Skr	0.095

NOTES

Primary sources are SIND79 (State Board of Industry (SIND) Energy Forecast to 1985, revised in 1977), including 1978 figures supplied ahead of publication, as well as data from Esso, SCB. and VVF, which were used to derive the total number of dwellings using each fuel as a principal source of heat.

The figures on quantities of energy consumed reflect supplementary heat produced by fuels other than the principal heat sources for SFD. Wood and electricity were used for supplementary heat in about 170,000 oil-heated dwellings -- 5 PJ of wood and 2 PJ of electricity. Wood was used in about 190,000 electrically-heated dwellings -- 6 PJ. The use of these supplementary fuels is not reflected in the unit consumption given under oil and electric heat. Small electric heaters are estimated by SIND to consume a total of about 2 PJ.

SIND gives unit consumption for SFD/MFD and numbers of district heat, electric, and "other" heating systems, and fuel totals for the entire sector; these are based on surveys by SCB. Swedish Esso and Oljekomsumenterna give figures for oil consumption/dw. For electric and district heat the value given for heat/dw reflects total consumption divided by mid-year average number of dwellings. We derive the number of dwellings using gas and coke for heating by dividing total coke or gas use by average fuel heat/dwelling based upon 1963 estimates for coke, wood, and Stockholm data for gas. Estimates for gas based upon our survey of 7 city gasworks. Our derivations for gas-heated dwellings are higher than those given by SCB. The second value in the SFD heat column (11.3 PJ) for wood reflects supplementary use of wood in electrically and oil heated dwellings, according to SIND. The first value refers to dwellings using wood as primary fuel.
Note: Heat/dw/DD, with electricity and district heat not adjusted = 16.9 MJ.

Hot water was removed from the heat totals by using figures found in the EBU and elsewhere: 12 GJ/dw for district-heated apartments (Sw.Dist.Htg Assoc.), 18 GJ/dw for district-heated SFD (same consumption/person), similar figures for electricity. 20/30 GJ/dw for fuel heat. The last figure may be an underestimate because of the inefficiency of central oil boilers in the four non-heating months. The apartment and electric figures may be an overestimate. According to R. Askerlund. Sw. State Power Board, there are few electric water heaters in dwellings without electric heat.

Gas cooking was determined using the average consumption/customer for Stockholm and Gothenburg, 2.7 GJ, times the number of stoves (from CDL 79). Wood stoves were estimated from CDL, and we assumed 2.5 GJ/stove; the majority of these stoves are found in larger rural/farm dwellings. Electric stove saturation was from SCB 1978 and CDL 1979, the specific

consumption from FERA (750kwh/yr), and no distinction is made between ovens and stoves.

Electric appliances were estimated by taking the SIND figure for "hushaallsel" (operating electricity) and subtracting off the total electric consumption for stoves. SIND gives "drift-el"(maintenance electricity) for apartments and SFD. The SIND figures include FF, estimated by them as 85% of the figure actually shown in SCB reports.

RESIDENTIAL ENERGY USE - SWEDEN

Year: 1972 Population: 8.122×10^6 Occ. Dw: 3.27×10^6

SFD: 42% DI/cap,(Skr_{70}): 11430 Climate Index: 0.97

	Heat	Hot Water	Cooking	Appliances	Total
Oil,PJ	198	52.5	-	-	250
-Stock,10^3	920/1238	920/1238			
-Unit Cons.,GJ	134/60	30/20			
Gas,Kero,PJ	2.7	0.4	1.1		4.2
-Stock,10^3	20/25	20/?	360		
-Unit Cons.,GJ	80/40	20/?	3.0		
Wood,PJ	11+4	1	0.25		16.3
-Stock.10^3	170/10	40/	130		
-Unit Cons.,GJ	60	25	2		
Coal,Coke,PJ	1.7	0.5			2.2
-Stock,10^3	28/5	24/			
-Unit Cons.,GJ	60	20/			
Elec,PJ	8.3	5.8	8.1	31.6	53.8
-Stock,10^3	194/29	300/40	2780	3270	
-Unit Cons.,GJ	39.2/24.6	18/12	2.9	10.3	
-Dist Ht,PJ	24.2	10.2	-	-	34.4
-Stock,10^3	20/570	20/570			
-Unit Cons.,GJ	60/40	20/17.2	-	-	
TOTAL,PJ	249	70.4	9.5	31.6	361
	(69%)	(20%)	(3%)	(9%)	(100%)

STRUCTURAL INDICATORS:		ENERGY USE INDICATORS:	
% dw oil heat	66	GJ/dw,end-use	110
% dw dist heat	18	GJ/dw,primary	143
% dw elec heat	7	% oil, end-use	69
% central heat	95.3	% elec, end-use	15
	(91/98)	Heat/dw/DD,MJ	20.3
		Appl elec/DI,kWh/Skr	0.095

NOTES

Data from SIND77 (State Board of Industry Energy Forecast to 1985, published in 1977). Data similar to SIND79 described above. No data on wood consumption, detailed estimates of all other fuels. More recent material from SIND (L.G. Carlsson, priv. comm.; see also the 1980 SIND Forecast) puts total consumption at 16 PJ. The second figure under SFD reflects supplementary use of wood in dwellings heated by oil and electricity. Dwelling numbers given by SIND were year-end totals, hence they overestimated rapidly growing electric and district-heated dwellings that existed for the entire year. We corrected these to mid-year estimates using SCB electric heat data and VVF district heat data. For electric heat the unit consumption reflects total consumption divided by mid-year average number of dwellings. Coke, gas, and kerosene-heated dwellings estimates are from estimated unit consumption and known total consumption (SIND), assuming mostly non-central heat. Some information on central heat (solids, gas) was available from SSPB surveys and the gasworks. Unit consumption for oil reflects figures from Esso; all dwellings are centrally heated. Other unit consumption figures for fuels are from SOU67, weighted to reflect the mix of central and non central heating.
Note: Heat/dw/DD, with electricity and district heat not adjusted, = 18.9 MJ

Hot water estimated as for 1978. Again we assume centrally heated dwellings have similar fuels for hot water. However, unpublished surveys by the Sw. State Power Board indicate that roughly 105,000 SFD and 10,000 MFD had separate electric hot water heaters. We include these in the electric hot water column. We estimate that nationally 95% of all dwellings had running hot water. We have estimate the shares of solid fuels as a residual.

Gas cooking was determined using the average consumption/customer for Stockholm, 3 GJ, times the number of stoves interpolated from FERA 1969, and CDL 73. Wood stoves were estimated from FERA and CDL. We assume 2 GJ/stove/yr. Electric stove saturation is from FERA 1969 and CDL 1973, the unit consumption from FERA interpolated linearly between values for 1978 and 1960.

Electric appliances, as in later years, were estimated by taking the SIND figure for "drift-el" (operating electricity) and subtracting off the total electric consumption for stoves. SIND gives "drift-el" for apartments and SFD. The former include electricity in communal spaces, in contrast with figures for earlier years. There is probably some hot water and non-central electric heat included here. By comparison, SCB gives 49.7 PJ for total electricity consumption exclusive of apartment communal electricity.

RESIDENTIAL ENERGY USE - SWEDEN

Year: 1965 Population: 7.734×10^{6}d Occ. Dw: 2.875×10^{6}
SFD: 45% DI/cap, Skr_{70}: 10930 Climate Index: 1.06

	Heat	Hot Water	Cooking	Appliances	Total
Oil,PJ	138	39.5	-	-	177
-Stock,10^3	545/1155	545/1155			
-Unit Cons.,GJ	130/58	30/20			
Kerosene,PJ	3.3	0.1	-	-	3.4
-Stock,10^3	40/10	10/			
-Unit Cons.,GJ	80/20	10			
Gas,PJ	1.3	0.3	1.7	-	3.3
-Stock,10^3	~15/10	~15	540		
-Unit Cons.,GJ	~80/30	20	3.2		
Wood,PJ	46.6	4.0	0.5	-	51.1
-Stock,10^3	455/95	150/	200		
-Unit Cons.,GJ	80/55	25	2.5		
Coal,Coke,PJ	17.0	2.5			19.5
-Stock,10^3	215/130	100/25			
-Unit Cons.,GJ	75/25	20			
Elec,PJ	1.0	1.0	6.0	20.2	28.2
-Stock,10^3	20/5	100	1905	2875	
-Unit Cons.,GJ	35/25	10	3.15	7.0	
Dist Ht,PJ	6.8	3.6	-	-	10.4
-Stock,10^3	5/175	5/175			
-Unit Cons.,GJ	60/41	17			
TOTAL,PJ	214	51.0	8.2	20.2	293
	(73%)	(17%)	(3%)	(7%)	(100%)

STRUCTURAL INDICATORS:		ENERGY USE INDICATORS:	
% dw oil heat	61	GJ/dw,end-use	102
% dw dist heat	6	GJ/dw,primary	121
% dw elec heat	1	% oil,end-use	62
% dw central heat	85	% elec, end-use	10
	(75/90)	Heat/dw/DD,MJ	18.9
		Appl elec/DI,kWh/Skr	0.066

NOTES

Basic information is from SOU67, FERA64,and FOB. FOB65 was used to reduce the number of dwellings in SOU67 to the correct total: 77000 central heat-SFD and 77,000 central heat-MFD, as well as 11,000 non-central heat MFD were removed, principally from oil but also from coke, wood, and "other" in smaller amounts. We assume that virtually all oil heated dwellings, and all with electric and district heat are centrally heated. Rouglhly half of the SFD with solid fuels, gas, and kerosene are centrally heated.
Oil heated dwellings based upon our revision of SOU67 and Esso. District heating has been excluded.
SOU67 gives a greater number of wood central heating than in 1963, which is difficult to explain. Limited data on new homes built in 1963 and 1964 indicate almost no wood systems in these homes, and we find it difficult to believe that so may homes would convert to central wood heat in a time when oil dominated the new home market. Therefore the figures for wood should be treated with caution. We have revised the 1963 figures according to Esso's calculationss. Data from Swedish Esso largely corroborate our estimates of oil and other fuels for 1965.
District heat was derived from VVF deliveries using the climate factor of 1.06 for 1965, electric from SOU and FERA, assuming SOU67 was calculated for a "normal" winter. These were removed from central heat-oil in SOU67. Our derivations were somewhat higher than those given in a private communication by Swedish Shell.
SOU67 listed gas and kerosene together, so division herein is approximate. However, partial information from six gasworks supports our estimate of number of gas heated dwellings. FERA estimates 1% electric heat, confirmed by conversation with R. Askerlund, Vattenfall.

Gas and electric stoves saturation is given in FOB65, wood stoves in FERA64 and FERA69.
Note: Heat/dw/DD, with electricity and district heat not adjusted, = 18.6 MJ

Hot water was estimated as in other years for central heat, separate electric water heaters, and gas water heaters. Wood and coke energy for hot water is estimated. Based upon 66% of dwellings having running hot water in 1960 we estimate that this figure reached 80% in 1965. This means that most homes without central heat and many centrally heated with solid fuels had no running hot water.

Appliance electricity is the residual after heat, hot water, and cooking are deducted. We estimate 700 GWh (2.5 PJ) commons apartment electricity (Fastighets Foervalting). For the total we use SCB Res+Agricultural dwellings + 2.5 PJ FF.

RESIDENTIAL ENERGY USE - SWEDEN

Year: 1963 Population: 7.66×10^6 Occ. Dw: 2.79×10^6

SFD: 46% DI/cap, Skr_{70}: 10245 Climate Index: 1.09

	Heat	Hot Water	Cooking	Appliances	Total
Oil,PJ	118	34.3			152
-Stock,10^3	420/1085	420/1085			
-Unit Cons.,GJ	130/58	30/20			
Gas,Kerosene,PJ	8.0	0.5	1.9	-	10.4
Units,10^3	70/60	30?	580		
-Unit Cons.,GJ	~50/~20	~15	3		
Wood,PJ	44.0	3.5	0.5		48.0
-Stock,10^3	475/100	175	200		
-Unit Cons.,GJ	75/50	20	2		
Coal,Coke,PJ	29.8	1.5			31.3
-Stock,10^3	300/155	75			
-Unit Cons.,GJ	75/50	20			
Elec,PJ	0.3	1.0	5.5	17.8	24.7
-Stock,10^3	10/	100	1730	2795	
-Unit Cons.,GJ	~30	~10	3.2	6.4	
Dist Ht,PJ	4.6	2.3			6.9
-Stock,10^3	5/110	5/110			
-Unit Cons.,GJ	41	23			
TOTAL,PJ	205	43.1	7.9	17.8	274
	(75%)	(16%)	(3%)	(6%)	(100%)

STRUCTURAL INDICATORS:		ENERGY USE INDICATORS:	
% dw oil heat	57	GJ/dw,end-use	98
% dw elec heat	<0.5	GJ/dw,primary	115
% dw dist heat	4	% oil, end-use	58
% dw central heat	83	% elec, end-use	9
	(68/88)	Heat/dw/DD,MJ	18.5
		Appl elec/DI, kWh/Skr	0.063

NOTES

Basic data are from SOU67, FERA64,and FOB. Heating structure for 1963 is from FERA, backstrapolated to 1963 by removing new oil-heated dwellings and conversions. Some information on heating sources of new dwellings was available from SCB, and most were oil or district-heated. SOU 67 assumed about 115000 more dwellings than existed. They note in footnote that they had underestimated demolitions. These may be presumed to be "lowest quality" dwellings -- with wood or coke non-central heat. Therefore we adjust the SOU67 figures by removing equal numbers of dwellings heated by these solid fuels. SOU 67, FERA 64, and FOB agree on total numbers of central heated dwellings, and dwellings heated with oil. Private estimates by Esso confirm our own. We use these to approximate the numbers of non-oil heated dwellings.
Oil is nearly all central heat, kerosene only about 20% central heat, gas SFD are central heat, MFD mostly non-central heat, wood is 65% central heat, coke 90% central heat.
District heating is removed from Esso data on oil heat using VVF figures on the number of DH-heated dwellings. These are derived by taking average of 62/63 and 63/64 season consumption for apartments and dividing by standard 57.6 GJ/dw, of which 30% is hot water. Comparing the FERA 1964 results with 1963, note that of the 45,000 net additions, most had either oil or district central heating. Since VVF indicates an increase of roughly 25000 dwellings between 1963 and 1964, and since the increase in electric heating is negligible, we know that there were about 20000 fewer oil-heated dwellings in 1963 than in 1964 due to completions and, according to SOU67, about 25000 fewer due to conversions to oil in 1964. From FERA 64 we find 80000 non-central oil dwellings (20000 using heating oil, according to SOU, leaving 60000 kerosene), about 35000 non-central gas, 15000 central gas, 220000 non-central solids of which 30000 are coke and 19000 wood. This breakdown gives the approximate total of fuel and district heat for 1963. We assume 10000 electrically-heated dwellings; FERA gives 1%, but data from 1965 suggest that this figure is too high.
Note: Heat/dw/DD, with electricity and district heat not adjusted, = 18.3 MJ

Hot water was obtained as in other years. Electric water heaters at the time were small; we assume 10 GJ/yr since they were found mostly in homes without central heat. FERA 64 indicated that 4% of all homes had electric heaters, presumably those homes without central heating.

Saturation of wood, electric, and gas stoves come from FERA64. We assume growth in electric stoves and linear disappearance of gas stoves between 1960 and 1964 to find the 1963 value. Our survey of city gasworks corroborates this estimate for gas stoves. Unit consumption for gas is from Stockholms Energiverk, for electricity from FERA. Note that in 1963 the majority of electric stoves were in SFD, hence serving larger families than gas stoves.

Electric appliances is the residual from total residential plus agricultural electricity plus 500 GWh apartment common electricity (FF), minus stoves, hot water, and the small amount of electric heat (non-central) listed in SOU67. We have probably included some electric heat and hot water here as well as in the 1965 figures. The SCB total is based on their Res.+Agricultural Homes + 1.8 PJ FF.

SUMMARY

RESIDENTIAL ENERGY USE IN SWEDEN 1960-1978

YEAR	1963	65	72	78
		STRUCTURE		
Occ. Dw, (10^3)	2790	2875	3270	3630
SFD %	46	45	42	43
Cen Ht %	83	85	94	99
SFD/CH %	72	75	90	97
Area,sq.m.	75	77	82.5	86
Area/cap	27.4	28.6	33.2	37.7
Pers/dw	2.74	2.68	2.49	2.28
Hot water sat.,%	75	80	97	>99
DI/cap,(Skr_{70})	10245	10930	11430	13900
		ENERGY TOTALS		
End-use (PJ)	274	293	361	371
-fuel (PJ)	241.7	254.3	272.7	237.0
-elec (PJ)	24.7	28.2	53.8	81.1
-dist ht (PJ)	6.9	10.4	34.4	52.7
-energy/dw (GJ)	98	102	110	102
Primary -energy/dw (GJ)	115	121	143	148
		HEAT		
Fuel,PJ	200	206	217	185
-sat.,%	95	93	75	62
-fuel/dw,GJ	75	77.2	88	81.6
Elec,PJ	0.3	1.0	8.3	20.6*
-sat.,%	<1	1	7	14
-elec/dw,GJ	30	37	37	41.4*
Dist Ht,PJ	4.6	6.8	24.2	37.3
-sat.,%	4	6	16	24
-dist ht/dw	40.0	37.8	41.0	43.2
Total,PJ	205	214	249	245
Indicators:				
-Heat/dw,GJ	74.3	75.8	81.4	76.6
-Heat/dw/DD,MJ	18.5	18.9	20.3	19.1
-Heat/dw/DD/m^2,KJ	245	245	245	220

RESIDENTIAL ENERGY USE IN SWEDEN 1960-1978 (continued)

YEAR	1963	65	72	78
		HOT WATER		
Fuel,PJ	39.8	47.1	55.4	50.5
-sat.,%	67	71	70	59
-fuel/dw,GJ	22.3	23.0	22.7	24.2
Elec,PJ	1.0	1.0	5.8	8.6
-sat.,%	4	4	10	16
-elec/dw,GJ	10	10	17	17.4
Dist Ht,PJ	2.3	3.6	10.2	15.4
-sat.,%	4	6	16	24
-dist ht/dw,GJ	20.0	20.0	17.3	17.8
Total,PJ	43.1	51.7	71.4	76.9
Indicators:				
HW/dw,GJ	22.4	23.7	24.0	23.4
HW/cap,GJ	8.2	8.8	9.7	10.2
HW/cap(tot),GJ	5.8	7.0	9.4	10.3
		COOKING		
Fuel,PJ	2.4	2.2	1.4	1.05
-sat.,%	28	26	15	11
-fuel/dw,GJ	3.1	3.0	2.8	2.6
Elec,PJ	5.5	6.0	8.1	8.7
-sat.,%	62	66	85	89
-elec/dw,GJ	3.2	3.15	2.9	2.8
Total,PJ	7.9	8.2	9.5	9.8
Indicator:				
-energy/dw,GJ	3.2	2.9	2.9	2.7
-energy/cap,GJ	1.05	1.05	1.15	1.15
		APPLIANCES		
Elec,PJ	17.8	20.2	31.	39.4
Elec,TWH	4.94	5.61	8.78	10.9
-elec/dw,GJ	6.4	7.02	9.66	10.9
-elec/dw,kWh	1770	1950	2680	3010
Indicators:				
-elec/cap,kWh	645	725	1080	1320
-elec/DI,kWh/Skr	0.063	0.066	0.095	0.095

NOTES

These data are assembled from the detailed year tables. Recall that electricity and district heat are adjusted to fossil fuel equivalents in the aggregate heat and hot water indicators. For 1965 and 1972, data on water heating are extremely uncertain, and unit consumption for cooking was assumed (from literature). Wood cooking data is also uncertain. Using assumptions about cooking and water, appliance electricity was derived from total use.

Disposable income is from "National Accounts 1963-1977", SCB N1978:8.4, given to three significant figures as household disposable income per capita. Small error included since 2% of population does not live in households included in residential electricity consumption data, but the error is approximately the same for each year.

Data on size of dwellings is based upon FOB, as revised by Esso (Private communication) using data on taxation. Since 1970 accurate data on the size of dwellings has been maintained in Sweden, but data from earlier years is derived from the number of rooms per dwelling. Area per capita is calculated using the known number of people/dwelling, based upon FOB calculations for actual dwellings, excluding the non-dwelling population again.

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UNITED KINGDOM

Detailed breakdowns of energy use in the residential sector were not available from any of the official sources in the United Kingdom (U.K.). We found some sectoral information on gas and electricity consumption from British Gas (B.G.) and the Electricity Council (E.C.), but there are no indications of a more comprehensive analysis from the Department of Energy (D/En) covering the 1960-78 period. More complete estimates for 1978 were recently available to us from the "Energy Technology Support Unit for the Department of Energy" (ETSU). Unfortunately, there are many other private surveys of energy use and equipment that were withheld from us, although the aforementioned groups were especially kind in showing us their most comprehensive data.

As shown in the explanatory notes to each table and in the bibliography, we often refer to "unofficial" sources, and mainly to the International Institute for Environment and Development (IIED), where Gerald Leach and his group have been studying major trends and future scenarios of energy use in the U.K. Their help and collaboration has been essential to this attempt of historical breakdown.

A series of specific adaptations have been necessary to complete the tables of United Kingdom with some consistency.

• We use here the number of households, as estimated at mid-year by Leach, instead of the occupied dwellings that are available from official sources, but only for census years.

• No official figure was available for an average Climate Index over the entire country. The figures presented here have been derived from population-weighted figures calculated by IIED using data from the Building Services Research and Information Association. The figures from Leach use 15.5° C as a base. We have converted them to degree-days with base 18° C by estimating an average heating season of 215 days (Leach, pers. comm.). The index is based on a 20 year mean, 100 = 2917 DD. With a change of this magnitude the absolute sizes of the yearly variations are bound to change, but we were forced to use the existing variations to base 15.5° C. Since most of the heating figures have been estimated for the first time within a closed matrix, and since the degree-day index has been re-evaluated on a new base, we have not corrected energy consumption for climate. Thus, only the indicators "Heat/dw" and "Heat/dw/DD" account for yearly weather differences.

-- Oil includes Liquid Petroleum Gas, which is used in negligable quantities. "Gas" is progressively shifting from City Gas in the early 1960s to predominantly Natural Gas in the 1970s.

Note: Figures under Heat given in parentheses refer to central heating. Figures given in brackets under Appliances refer to gas appliances, which are not included in the appliances totals.

RESIDENTIAL ENERGY USE - UNITED KINGDOM

Year: 1978 Population: 55.9×10^6 Occupied Dw: 20.11×10^6

SFD: 78% DI/cap, L_{70}: 678 Climate Index: 98.6

	Heat	Hot Water	Cooking	Appliances	Total
Oil,PJ	117	29.8	3.1	-	150
-Stock,10^3	1390(1100)	1300	280		
-Unit Cons,GJ	84.2	23	11.1		
Gas,PJ	532(331)	124	109	[1.5]	766
-Stock,10^3	11130(5800)	8500	11000	[1090]	
-Unit Cons,GJ	47.8(57.1)	14.6	9.9	[3.2]	
Solids,PJ	332	59.2	3.0	-	394
-Stock,10^3	5060(1400)	3000	230		
-Unit Cons,GJ	65.6	20.0	13.0		
Elec,PJ	72.5	62.4	32.3	142	309
-Stock,10^3	6630(2600)	11060	8600	20110	
-Unit Cons,GJ	10.9	5.2	5.5	7.1	
Dist Ht,PJ	NA	-	-	-	NA
-Stock,10^3	[80]	-	-		
-Unit Cons,GJ	NA	-	-		
TOTAL,PJ	1054	275	147	143	1619
	(65%)	(17%)	(9%)	(9%)	(100%)

STRUCTURAL INDICATORS:		ENERGY USE INDICATORS:	
% dw oil heat	6	GJ/dw,end-use	81
% dw elec heat	27	GJ/dw,primary	110
% dw dist heat	<1	% oil, end-use	9
% dw central heat	54	% elec, end-use	19
		Heat/dw/DD,MJ	18.8
		Appl elec/DI,kWh/L_{70}	1.05

NOTES

Total consumption of the various sources was available from the Department of Energy (14), and refers to end-use forms of delivered energy. Fuel consumption by end-use has been recently calculated by ETSU (22). We have combined the data from this source with the information gathered from local experts (3,9,16).

Most of the stocks figures have been derived from ETSU estimates, from data obtained in personal communications with B.G., and from the E.C. 1978 Survey (12). For space heat, the figures in parentheses refer to the stock of central-heated households, while the first figure also includes "main living room systems" and stoves. The total number of heating systems is larger than the number of households, since on the average there is more than one heating system per dwelling. The saturation indicators are calculated assuming that the different types of stoves are equally distributed within the stock without central heating.

Central heating from ETSU corresponds to the stock figures available from B.G. The figure is confirmed by the Family Expenditure Survey (1978) by D/En, which splits the central heating stock as follows: 54% gas, 24% electricity, 12% solids, 9% oil, 1% district heating. The dominant mode for central heating systems (almost 8 million) is a boiler with a dual space heating and water heating function. The combined system leads to a series of observations: first, boilers used just for water heating during the non-heating seasons are grossly oversized; second, most of the abundant electric hot water heaters are used only during the summer; thus, the analysis of hot water energy use by itself is an artificial distinction that can only be made by some pro-rating assumptions on water use, heating seasons, etc.

The gas consumption for hot water refers to the stock of centrally heated dwellings and to 2.7 million water heaters with an average consumption of 14 GJ/year (ETSU).

District heating consumption is included in the totals of each fuel used as primary source (the stock of district-heated dwellings, 80000, is given by D/En in its Family Expenditures Survey 78).

For the calculation of Cooking energy consumption and stocks we have considered various data from ETSU, E.C. and B.G., adding the shares for Scotland from the local utilities (7, 19). Oil and solids cooking has been estimated from some data from the electric utilities, although B.G. and other sources (ETSU) consider it negligible.

A considerable stock of gas-burning appliances is still working in the U.K. The figures in brackets refer to 660000 gas refrigerators and freezers, 385000 gas washing machine boilers, and 45000 gas dryers (all estimates from B.G.). These figures are not included in Appliances energy use.

RESIDENTIAL ENERGY USE - UNITED KINGDOM

Year: 1975 Population: 55.9×10^6 Occupied Dw: 19.56×10^6

SFD: 75% DI/cap, L_{70}: 721 Climate Index: 96.0

	Heat	Hot Water	Cooking	Appliances	Total
Oil,PJ	131	20	~0	-	151
-Stock,10^3	1460	1000	~0		
-Unit Cons,GJ	90	20	-		
Gas,PJ	427(235)	82	106	[7.6]	622
-Stock,10^3	11400(3450)	5730	11560	[2400]	
-Unit Cons,GJ	37.5(68)	14.3	9.2	[3.2]	
Solids,PJ	336	122	~0	-	458
-Stock,10^3	5420(1470)	6100	~0		
-Unit Cons,GJ	62.0	20	-		
Elec,PJ	96.4	72.3	34.5	118	321
-Stock,10^3	6560	12050	8000	19560	
-Unit Cons,GJ	14.7	6.0	4.3	6.0	
Dist Ht,PJ	NA	-	-	-	0
-Stock,10^3	NA	-	-	-	
-Unit Cons,GJ	NA	-	-	-	
TOTAL,PJ	990	296	141	126	1552
	(64%)	(19%)	(9%)	(8%)	(100%)

STRUCTURAL INDICATORS:		ENERGY USE INDICATORS:	
% dw oil heat	6	GJ/dw,end-use	79
% dw elec heat	26	GJ/dw,primary	110
% dw central heat	40	% oil, end-use	10
		% elec, end-use	21
		Heat/dw-DD,MJ	19.0
		Appl elec/DI,/L_{70}	0.81

NOTES

The most complete published study of the end-use of energy in the United Kingdom has been undertaken by Gerald Leach in his book A Low Energy Strategy for the United Kingdom (2), which based its analysis on 1975 energy consumption. However, since the residential sector is evaluated on a "useful energy" basis, most of the energy figures presented cannot be directly transfered to our table formats.

Totals of fuels are from D/En as for 1978. Gas consumption by end-use and stock figures have been estimated on the base of 1974 data provided by B.G. (18). The Appliance use of gas refers to refrigerators, wash-boilers, and pokers; we mention it in brackets because we do not include it in Appliance energy. The central heating figure is from IIED.

Disaggregation of electric uses and stocks are from The Electricity Council ("Domestic Sector Analysis", 1977) to which we have added the figures for Scotland from the local utilities. Stocks have been calculated from E.C. and Scotland Hydro-Electric Board as mid-year estimates, and refer to the number of systems in use. The central heating systems providing hot water are estimated by B.G. to be 6 million. We have avoided the possible underestimation of hot water energy use by calculating it consistently with 1978 estimates. Consistent estimates for Heat and Hot Water stocks were available from Leach.

For space heat stocks, note that gas and electricity figures refer to the number of systems (central heating subtotal is in parenthesis when available), while the figure for solids refers to the number of houses heated by these fuels (from B.G.).

Oil and solids cooking figures are not available. Since this quantity should be less than 5% of the cooking share, we assume it insignificant and included in gas.

RESIDENTIAL ENERGY USE - UNITED KINGDOM

Year: 1970 Population: 55.4×10^6 Occupied Dw: 18.59×10^6

SFD: 73% DI/cap, L_{70}: 626 Climate Index: 98.6

	Heat	Hot Water	Cooking	Appliances	Total
Oil,PJ	123	18	~0	-	141
-Stock,10^3	1370	850	~0		
-Unit Cons,GJ	90.0	21.0	-		
Gas,PJ	224(124)	36	105	[10]	374
-Stock,10^3	6900(1900)	2430	11700	-	
-Unit Cons,GJ	32.5(65)	14.6	9.0	-	
Solids,PJ	555	198	~0	-	753
-Stock,10^3	9520(1480)	8600	~0		
-Unit Cons,GJ	58.3	23.0	-		
Elec,PJ	89.9	70.4	28.9	88.1	277
-Stock,10^3	7310	10830	6880	18590	
-Unit Cons,GJ	12.3	6.5	4.2	4.7	
Dist Ht,PJ	NA	-	-	-	0
-Stock,10^3	NA	-	-		
-Unit Cons,GJ	NA	-	-		
TOTAL,PJ	992	322	134	98	1545
	(64%)	(21%)	(9%)	(6%)	(100%)

STRUCTURAL INDICATORS:		ENERGY USE INDICATORS:	
% dw oil heat	6	GJ/dw,end-use	83
% dw elec heat	29	GJ/dw,primary	111
% dw central heat	30	% oil, end-use	9
		% elec, end-use	18
		Heat/dw/DD,MJ	19.4
		Appl elec/DI, L_{70}	0.71

NOTES:
See the notes for 1975.

RESIDENTIAL ENERGY USE - UNITED KINGDOM

Year: 1961 Population: 52.8×10^6 Occupied Dw: 16.83×10^6

SFD: 70% DI/cap, L_{70}: 525 Climate Index: 92.8

	Heat	Hot Water	Cooking	Appliances	Total
Oil,PJ	NA	NA	2.0	-	77
-Stock,10^3	5500	100	200		
-Unit Cons,GJ	NA	NA	10.0		
Gas,PJ	NA	NA	93.6	-	137
-Stock,10^3	2300	NA	10400		
-Unit Cons,GJ	NA	NA	9.0		
Solids,PJ	NA	NA	12.5	-	1132
-Stock,10^3	16000	9800	1100		
-Unit Cons,GJ	NA	NA	11.0		
Elec,PJ	33.3	38.1	23.6	42.7	138
-Stock,10^3	4760	5970	5130	16830	
-Unit Cons,GJ	7.0	6.4	4.6	2.5	
Dist Ht,PJ	NA	-	-	-	0
-Stock,10^3	NA	-	-		
-Unit Cons,GJ	NA	-	-		
TOTAL,PJ	1060	250	132	43	1484
	(71%)	(17%)	(9%)	(3%)	(100%)

STRUCTURAL INDICATORS:		ENERGY USE INDICATORS:	
% dw oil heat	[33]	GJ/dw,end-use	88
% dw el heat	[28]	GJ/dw,primary	104
% dw central heat	8	% oil, end-use	5
		% elec, end-use	9
		Heat/dw-DD,MJ	23.6
		Appl elec/DI, L_{70}	0.43

NOTES:

Fuels totals are from IIED.
The stock figures for heating and hot water are derived from the Electricity Council 1961 survey.
The solids stock for heating accounts for 7.5 million systems with back-boiler used for hot water. These backfired systems for hot water are added also to the 2.3 million of independent hot water heaters. This should be considered in case some energy figures should be included in the table.
Only for cooking are there consistant energy data either from the gas and the electric utilities.

SUMMARY

RESIDENTIAL ENERGY USE IN UNITED KINGDOM 1961-1978

YEAR	1961	70	75	78
		STRUCTURE		
Dwellings, 10^6	16.83	18.59	19.56	20.11
SFD,%	70	73	75	78
Cen Ht,%	8	30	47	54
Cen Ht-SFD,%	NA	NA	NA	41
Avg Size,sq.m.	NA	NA	83	81
Pers/dw	3.14	2.98		2.78
DI/cap, L_{70}	525	626	721	678
Climate Index	92.8	98.6	96.0	98.6
		ENERGY TOTALS		
End-use,PJ	1484	1545	1552	1619
-fuel,PJ	1346	1268	1231	1310
-elec,PJ	138	277	321	309
-energy/dw,GJ	88	83	79	81
Primary				
-energy/dw,GJ	104	111	110	110
		HEAT		
Fuel,PJ	1027	902	894	981
-sat.,%	141	96	93	87
-fuel/dw,GJ	43.3	50.5	49.1	55.8
Elec,PJ	33.3	89.9	96.4	72.5
-sat.,%	28	39	34	33
-elec/dw,GJ	7.0	12.3	14.7	10.9
Dist Ht,PJ	NA	NA	NA	NA
-sat.,%	NA	NA	NA	[0.4]
-dist ht/dw,GJ	NA	NA	NA	NA
Total,PJ	1060	992	990	1054
Indicators:				
-heat/dw,GJ	68.1	56.6	55.3	55.0
-heat/dw/DD,MJ	23.3	19.4	19.0	18.8
-heat/dw/DD/m^2,KJ	NA	NA	230	230

RESIDENTIAL ENERGY USE IN UNITED KINGDOM 1961-1978 (continued)

YEAR	1961	70	75	78
		HOT WATER		
Fuel,PJ	212	252	224	213
-sat.,%	75	64	66	64
-fuel/dw,GJ	16.8	21.2	17.5	16.6
Elec,PJ	38.1	70.4	72.3	62.0
-sat.,%	35	58	62	55
-elec/dw,GJ	6.4	6.5	6.0	5.6
Total,PJ	250	322	296	275
Indicator:				
HW/dw(total),GJ	14.9	17.3	15.1	13.7
-HW/cap(total),GJ	4.7	5.8	5.3	4.9
		COOKING		
Fuel,PJ	108	105	106	115
-sat.,%	69	63	59	57
-fuel/dw,GJ	9.3	9.0	9.2	9.9
Elec,PJ	23.6	28.9	34.5	32.3
-sat.,%	31	37	41	43
-elec/dw,GJ	4.6	4.2	4.3	3.8
Indicator:				
-energy/dw,GJ	7.8	7.2	7.2	7.3
		APPLIANCES		
Elec,PJ	42.7	88.1	118	142
TWh	11.9	24.5	32.8	39.7
-elec/dw,GJ	2.5	4.7	6.0	7.1
kWh	705	1315	1675	1975
Indicators:				
-elec/cap,kWh	225	442	587	710
-elec/DI,kWh/L_{70}	0.43	0.71	0.81	1.05

NOTES

These data are assembled from the year tables.

Single Family Dwellings include detached houses, duplex, and bungalows (IIED). Dwellings area has been estimated using combined data from Housing and Construction Statistics (21), and from mortgages sampling (Nationwide Building Society [5,6]).

Saturation percentages for heating and hot water refer to the number of systems divided by the total number of households. The per-dwelling energy intensity is thus to be considered an average per-system.

The number of dwellings with hot water facilities is not known; thus the indicator "HW/dw" assumes that all dwellings have hot water.

The appliances summary refers to electric appliances only.

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SUMMARY INDICATORS

In the foregoing country reports we presented structural and energy use data for several years for each country. In this section we present key summary indicators from each country so that relative developments among the countries can be seen. While we emphasize that not all of the data and indicators are of equal quality, we feel that their comparison is useful in seeing general trends and differences among the countries.

As with the country reports, some approximations have been necessary, although we feel that they are reasonable. We have only attempted extrapolation or interpolation where absolutely necessary. We remind the reader of certain differences in definition, such as that of "single-family dwelling", or "central heating," that arise when all countries are compared.

Symbols and abbreviations are identical to those in the body of the text. For disposable income, each country's own currency in constant 1970 units was used. Thus, comparisons should be made between years within a country, but not between countries.

SUMMARY INDICATORS

-STRUCTURE-	1960-65	70-73	78-79
	% Central Heat		
CANADA (61-71-78)	67	81	93
FRANCE (62-73-78)	20	48	60
GERMANY (60-72-78)	16	49	66
ITALY (60-72-78)	~10	41	57
JAPAN (65-73-79)	<1	2	4
SWEDEN (63-72-78)	83	94	99
UK (61-70-78)	8	30	54
	% SFD		
CANADA	74	71	64
FRANCE	55	48	49
GERMANY	48	48	49
ITALY	22	22	29
JAPAN	72	65	65
SWEDEN	46	42	43
UK	70	73	78
	PEOPLE/DW		
CANADA	4.00	3.57	3.09
FRANCE	3.28	3.08	2.92
GERMANY	3.44	2.80	2.50
ITALY	3.91	3.51	3.40
JAPAN	4.05	3.50	3.20
SWEDEN	2.74	2.49	2.28
UK	3.14	2.98	2.78
	AREA/CAP (sq.m.)		
CANADA	24.4	27.3	32.2
FRANCE	19.8	23.4	26.4
GERMANY	19.8	26.6	30.4
ITALY	14.8	18.5	21.5
JAPAN	17.8	22.1	25.1
SWEDEN	27.4	33.2	37.7
UK	NA	NA	29.1

-ENERGY USE-	1960-65	70-73	78-79
	TOTAL END-USE ENERGY (PJ)		
CANADA	732	1094	1293
FRANCE	625	1438	1487
GERMANY	951	1792	2070
ITALY	300	920	1063
JAPAN	525	977	1183
SWEDEN	274	361	371
UK	1484	1545	1619
	END-USE ENERGY/DW (GJ)		
CANADA	164	181	170
FRANCE	42	83	80
GERMANY	62	84	87
ITALY	24	59	63
JAPAN	21	33	36
SWEDEN	98	110	102
UK	88	83	81
	PRIMARY ENERGY/DW (GJ)		
CANADA	194	239	249
FRANCE	48	95	100
GERMANY	68	102	110
ITALY	27	70	77
JAPAN	27	46	54
SWEDEN	115	143	148
UK	104	111	110

-INTENSITY-	1960-65	70-73	78-79
	HEAT/DW/DD (MJ)		
CANADA	28.6	31.5	28.7
FRANCE	16.0	30.6	26.1
GERMANY[a]	16.6	22.8	23.1
ITALY	9.8	24.3	22.4
JAPAN	3.9	7.6	7.1
SWEDEN	18.5	20.3	19.1
UK	23.3	19.4	18.8
	HOT WATER/CAP(TOT),GJ		
CANADA	4.7	7.6	10.5
FRANCE	1.1	3.0	3.8
GERMANY	1.1	3.2	4.7
ITALY	0.9	1.2	2.1
JAPAN	1.6	2.6	3.8
SWEDEN	5.8	9.4	10.2
UK	4.7	5.8	4.9
	COOKING/DW (GJ)		
CANADA	6.8	4.5	3.2
FRANCE	2.4	4.4	5.9
GERMANY	4.5	2.8	2.3
ITALY	3.4	3.6	4.6
JAPAN	4.7	5.4	5.1
SWEDEN	3.2	2.9	2.7
UK	7.8	7.2	7.3
	APPLIANCES (kWh/Dw)		
CANADA	2225	3665	4320
FRANCE	535	1115	1470
GERMANY	375	950	1225
ITALY	255	1060	1455
JAPAN	640	1345	2055
SWEDEN	1770	2680	3010
UK	705	1315	1975
	(kWh/DI), local currency		
CANADA,$C	0.30	0.38	0.39
FRANCE,FF	0.022	0.029	0.038
GERMANY,DM	0.022	0.043	0.053
ITALY,10^3Li	0.13	0.30	0.50
JAPAN,10^3Y	0.55	0.54	0.84
SWEDEN,Skr	0.063	0.095	0.095
UK,L	0.43	0.71	1.05

Notes

a - in this table we have converted the official German degree-day normal (used in the Germany section) to base 18o C degree-days (3163) in order to make the data more comparable with other countries.

Years covered:
Canada -- 1961, 1971, 1978
France -- 1962, 1973, 1978
Germany --1960, 1972, 1978
Italy --1960, 1972, 1978
Japan --1965, 1973, 1979
Sweden -- 1963, 1972, 1978
United Kingdom --1961, 1970, 1978

The reader should refer to the detailed year tables and country summary tables for more details, caveats, and other indicators.